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DEPARTMENT OF FISH AND GAME

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The Kelp Bass (*Paralabrax clathratus*) And Its Fishery, 1947-1958

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Marine Resources Operations

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FRONTISPIECE. A true-to-life assembly of kelp bass feeding around mussels. A black perch *(Embiotoca jacksoni)* and a white seaperch *(Phanerodon furcatus)* have joined the bass. *Photograph by Charles H. Turner.*

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ACKNOWLEDGMENTS

The skippers and deckhands of the southern California sportboat fleet were the chief sources of my information. Through their interest, and endurance, a small mountain of sport-catch logs became available for analysis. Numerous kelp bass were tagged from their boats, and most of the recoveries were brought in by them.

Robert D. Collyer initiated and supervised the statistical and biological work from 1946 through 1951. John L. Baxter spent long hours with the microscope and calculating machine working up data on weight-length, aging, and food studies. The efficient personnel in our Biostatistical Section worked patiently for years converting voluminous catch data into concise and graphic reports. Norman J. Abramson and the Technical Assistance and Analysis Unit suggested and guided much of the mathematical treatment. Other California State Fisheries Laboratory and Wildlife Protection personnel provided field assistance and inspirational suggestions. To all of these people, and with great pleasure, I offer my sincere thanks.

INTRODUCTION

Kelp bass, often termed "bull" or "calico" bass depending upon size, are non-migratory natives of California and Baja California marine waters. Their geographic range extends from about Monterey Bay, California, to Magdalena Bay, Baja California, but few are encountered north of Point Conception or south of Abreojos. They are abundant at Guadalupe and San Benitos Islands and Point Eugenia (Quast, n.d.). Girard first described the species, from San Diego, in 1854.

Kelp bass adults inhabit a wide bathymetric range from the surf zone to depths of 130 feet or more. Specimens of all sizes usually are distributed throughout the water column, and above and below any thermocline (Quast, n.d.). Fishing is commonly conducted in and near kelp beds along mainland and island shores.

Kelp bass number among the top five species in the California sportboat fishery. Although, barracuda (*Sphyraena argentea*), and collective members of the rockfish family (*Sebastodes* spp.), frequently outnumber kelp bass in the catch, from the standpoints of popularity, desirability and all-season availability, the bass is probably the preeminent species.

In 1947, veterans of the services and war-time industry began to exert unprecedented fishing pressure on fresh- and saltwater fishes. A population of large "bull" bass, accumulated during the war, absorbed much of the effort expended by the southern California saltwater angler. By 1950, most of the available "bull" bass had been caught, leaving a reduced population, individually smaller in size.

In 1949, sportfishing operations were being extended to remote offshore banks at San Clemente Island, and new landings were established in areas relatively undeveloped at Oceanside and Paradise Cove.

It was obvious to all concerned (California Department of Fish and Game, the partyboat industry, and organized as well as unattached sportfishermen) that the fishery was deteriorating. Consequently, the department instituted a research program in 1950, designed to determine the status of the stocks and to provide a basis for sound regulation, if such was in fact warranted.

It soon became evident that restrictions would be necessary before we could complete our investigations, so in 1953 the sale of kelp bass was prohibited and a size limit of 10½ inches was imposed on sportfishermen. The size limit was increased periodically until 1959 when it was stabilized at 12 inches, the level our investigation showed would be most beneficial.

Because of these steps the fishery is once again commencing to show prosperity. In 1961 and 1962, two and three years after the size limit was stabilized, southern California partyboats reported catches of 613,000 and 789,000 kelp and sand bass—comparing favorably with some of the better postwar years.

FISHERY

EXTENT AND FACILITIES

Sport boats from Gaviota to San Diego fish for kelp bass. Most operate from Port Hueneme, Santa Monica Bay, Los Angeles-Long Beach Harbor, Newport Beach, San Clemente, Oceanside, and San Diego. Within these boundaries, a maximum of 371 boats in 1953 and a minimum of 210 in 1958 were operating. The trend has been toward fewer boats carrying more anglers, particularly where business conditions permit consolidation of fishing facilities including landing, restaurant, tackle store, equipment repair and boats of different capacities (Figure 1).

FIGURE 1. Tackle store, ticket office and restaurant facilities, arranged for the convenience of the angler. In this photo, rental rods are marked with white butt ends.
Photograph by Jack W. Schott.

Sport-boat fishermen have a wide choice in matters of cost, departure time, and boat conveniences such as seaworthiness, galley service, and bunk facilities. In general, most operators allow 24 to 30 inches of rail space per man. Some of the newer and more spacious craft exceed this allowance. The four basic choices available to anglers are all-day, half-day, charter, and barge boats (Figures 2, 3 and 4).

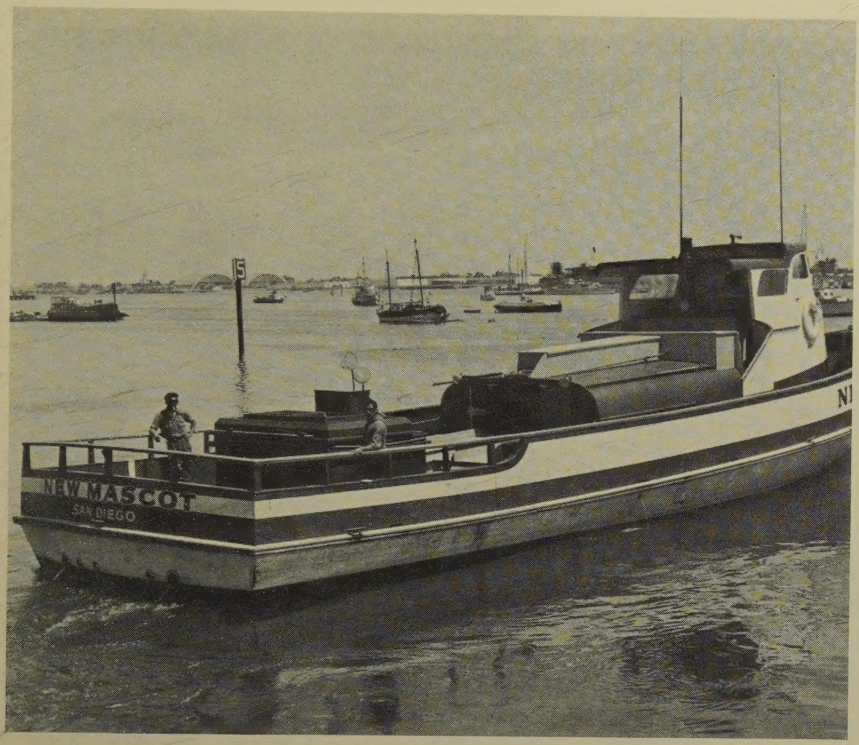


FIGURE 2. An all-day party boat of late design, about 65 feet long, carrying 60 passengers. About 30 boats of this type have been launched in recent years. Most are powered with twin-engine diesels. *Photograph courtesy H. & M. Sportfishers Inc., San Diego.*

All-day boats vary in length, but tend to be among the largest in the fleet, carrying up to 60 or more fishermen. Departure times are scheduled for the season. Some leave as early as 1 A.M. followed by others regularly until about 7 A.M. A few boats run almost 24 hours a day, departing and returning on fixed schedules. Typically, a fisherman either phones or visits a landing and finds out what is available to him. His choice is determined by a number of personal factors. Assume, for example, he decides to reserve passage on the following Saturday. The fare will be $6.50 and departure time 4 A.M. He must furnish his own gear or rent from the landing tackle store. The boat always carries extra hooks, sinkers and lures, and occasionally line, but seldom has rods and reels. On further inquiry, the fisherman learns the destination is Santa Catalina Island, $2\frac{1}{4}$ hours traveling time at about $8\frac{1}{2}$ knots. The long ride over and back prompts him to rent bunk space at or about $1 for the trip. Blankets often are furnished (Figure 5). Bunk space may not be available for late-comers. The ship's galley provides breakfast and lunch at prices prevailing ashore (Figure 6). Coffee, beer, and soft drinks are available. Depending upon fishing and weather, return time may vary between noon and nightfall. Highly successful fishing means an early return and many legal limits of fish.

FIGURE 3. A water-taxi in use for sportfishing shortly after World War II. Craft of this type are being replaced by modern boats designed specifically for sportfishing.
Photo courtesy H. & M. Sportfishers Inc., San Diego.

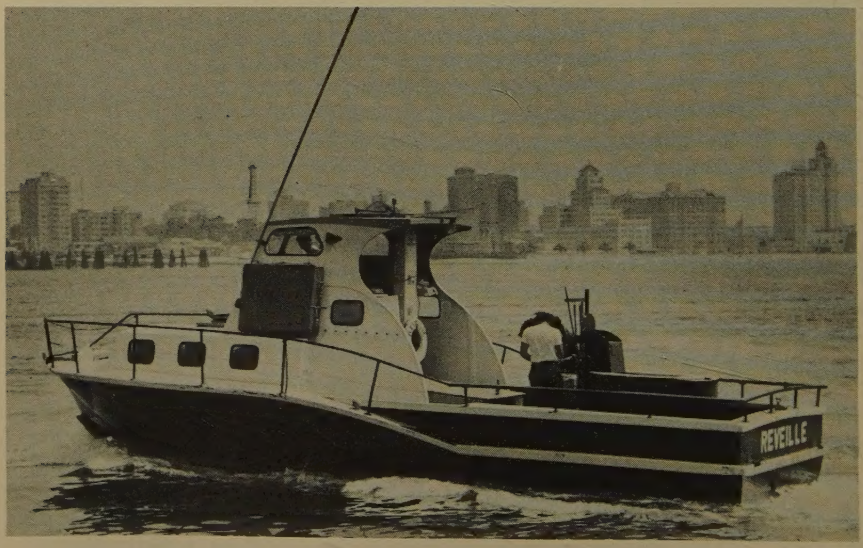


FIGURE 4. A charter-boat about 44 feet long, fishing 20 persons with bunks for 10. Charter boats are predominately owned by individuals and may or may not fish every day during the main season. A boat of this capacity charters for about $200.
Photo courtesy Pacific Sportfishing Inc., Long Beach.

FIGURE 5. Bunk room on the *Freedom*, one of the largest boats in the fleet.
Photo courtesy Pierpoint Landing Inc., Long Beach.

A fisherman having only a few hours to fish would select a half-day boat for his outing. Half-day boats depart at 6 A.M., return at 11:30 A.M., depart again at 12 or 12:30 and return around 5 P.M. A galley is available, but bunks usually are not because fishing is conducted relatively near the landing, providing maximum fishing time. Fare is about $2 or $3 less than for all-day boats.

Charter boats are leased by the day, with the skipper included. One or a group of persons may arrange for a trip. Food, departure time, departure place, fishing locality, number of fishermen, and boat rules

are settled well ahead of the fishing date. This type of boat is popular with club men, church groups, and large families. Charters may be made up months in advance.

FIGURE 6. The galley of the *Mission Belle*, a fine example of eating facilities available on many boats in the fleet. Food prices are reasonable and comparable with those of shoreside installations. *Photograph by Jack W. Schott.*

Barges are anchored craft, usually remaining in a fixed location throughout the fishing season. Relatively few kelp bass are caught from them.

FISHERY PRACTICE

Live bait fishes, usually anchovies *(Engraulis mordax)* (Figure 7) are used to lure and catch kelp bass, barracuda, rockfish, California yellowtail *(Seriola dorsalis)*, Pacific bonito *(Sarda chiliensis)*, jack mackerel *(Trachurus symmetricus)*, white seabass *(Cynoscion nobilis)*, California halibut *(Paralichthys californicus)*, and others. Live bait is obtained from a fleet of boats specializing in its capture and sale (Figures 8 and 9). Sportboat skippers pick up a load of live bait either before or after their passengers have boarded (Figure 10). Anchovies and other bait fishes are kept alive in a tank of circulating sea water. Arriving at the fishing grounds, the skipper cruises the boat in a circle

FIGURE 7. Anchovies are the most important live bait on sport boats. These specimens, about five inches long, were impaled with No. 2 hooks, showing two ways to fish anchovy baits. The monofilament leader is almost invisible. *Photograph by Jack W. Schott.*

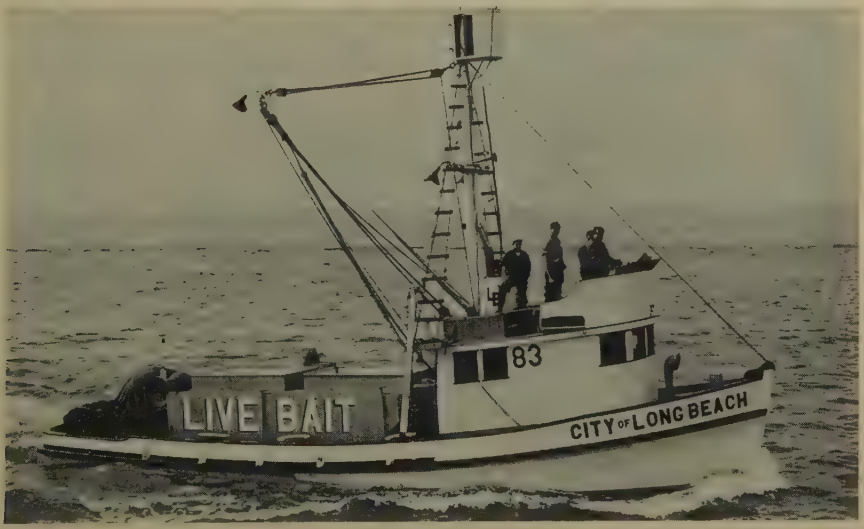


FIGURE 8. A modern, well-equipped live-bait boat approximately 40 feet long. A lampara net and a "drum" winch occupy the stern. The tanks can hold about 200 scoops (3,000 pounds) of live bait. *Photo courtesy Pierpoint Landing Inc., Long Beach.*

while a deckhand "chums" handfuls of bait overside. If a "boil" is seen, indicating feeding fish, the boat is anchored so the stern drifts down-current to the selected spot.

FIGURE 9. Live bait is netted during night and early morning hours in preparation for early sport boats. Here, bait is being scooped from the net to the holding tanks. A small skiff and hood of a powerful light appear in the background. Lights are used to attract and hold bait for capture. *Photo courtesy Pierpoint Landing Inc., Long Beach.*

Anglers hopefully cast or drop baited hooks into the water. Hook sizes, ranging from 8 to 2-0, are a matter of individual choice. Top-notch bass fishermen prefer to fish from the stern, casting their baits well away from the boat, toward or into kelp. Casting can also be done from the vessel sides, but baits drift down-current, often fouling the

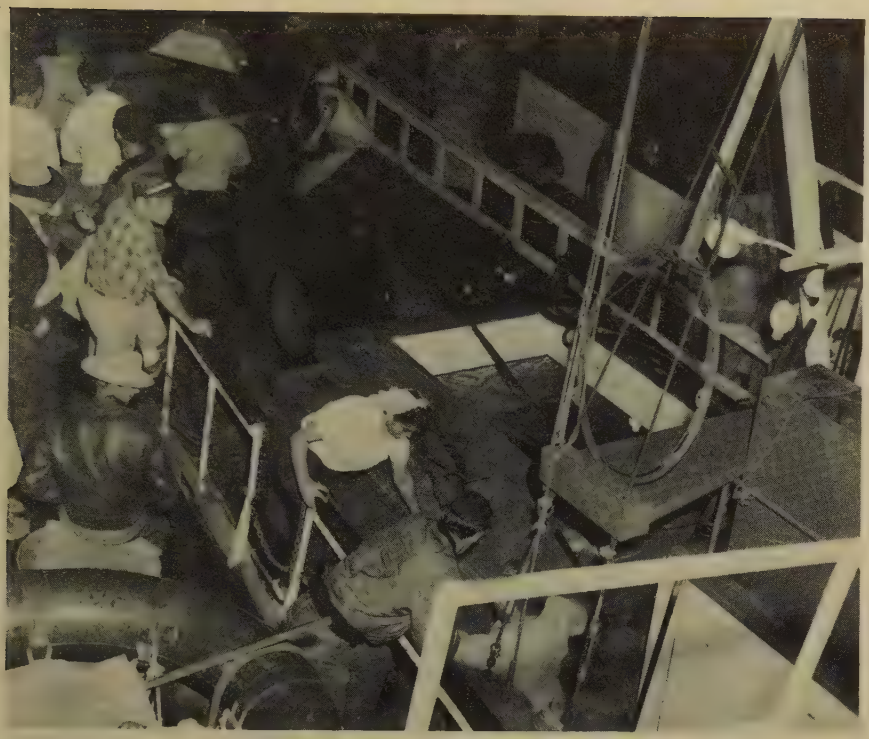


FIGURE 10. Two sport boats taking on live bait directly from the net, avoiding double handling and potential injury to the bait. The galley girl in the foreground is passing a cup of coffee to the bait boat skipper, a courtesy commonly extended to the hard-working bait crew. *Photo courtesy Pierpoint Landing Inc., Long Beach.*

lines of other fishermen. Large bass (bulls) seldom approach an anchored sport boat closely, but small 7- to 11-inch calicos, abundant in many areas, swarm directly beneath the boat and are seen attacking large bait in futile fury. Small or cut baits are quickly swallowed.

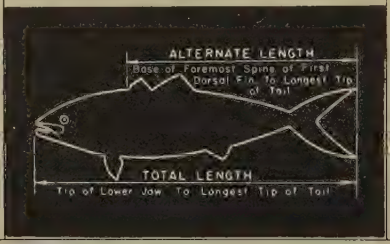
Bass, no matter what size, will bite on a hook if the offering can be seized. In a test conducted at San Clemente and Santa Catalina Islands during April 1955, 2- and 3-inch bass attacked bits of anchovy and abalone impaled on #12 and #16 trout hooks. The fishermen, equipped with underwater breathing apparatus, sat on the ocean floor dangling baited hooks near small bass. In moments, these fish would drift toward the bait and suddenly seize it. Appropriately-scaled tackle could be used to take almost any size bass, depending on the will of the fisherman.

REGULATION

In southern California, fishermen must contend with an array of salt-water regulations that are complicated by the sheer number of fish species involved. Both bag and size limits are in effect for four species, and an additional 16 species are on bag limits only (Figure 11).

ANGLING REGULATIONS 1962

a sportfishing license* is required for the taking of all fish, mollusks, and crustaceans (shellfish)

SPECIES	MINIMUM LENGTH	POSSESSION LIMITS
Barracuda Seabass, white Yellowtail Bass, kelp, sand	not more than 2 less than 28" total (17" alternate) not more than 2 less than 28" total (20½" alternate) not more than 5 less than 28" total (19" alternate) none less than 12" total length (8½" alternate)	15 FISH ALL SPECIES COMBINED BUT NOT MORE THAN 10 FISH OF ANY ONE SPECIES
Albacore Bonito Cabezon Corbina Croaker, spotfin, yellowfin Lingcod Opaleye Skipjack Tuna, bluefin, yellowfin		
Rockfish (rockcod)		20 fish
Halibut, California Bass, black sea Marlin Broadbill Swordfish		2 of each species
Perch, salt water — San Luis Obispo County and South — 10 per day, 25 elsewhere Shiner perch		25 statewide

garibaldi may not be taken

** sportfishing license not required to fish on public piers in waters of Pacific Ocean*

Consult 1962 Sportfishing Regulations for other laws and regulations

Official Notice posted under authority of section 225.7, Title 14, of the Calif. Admin. Code

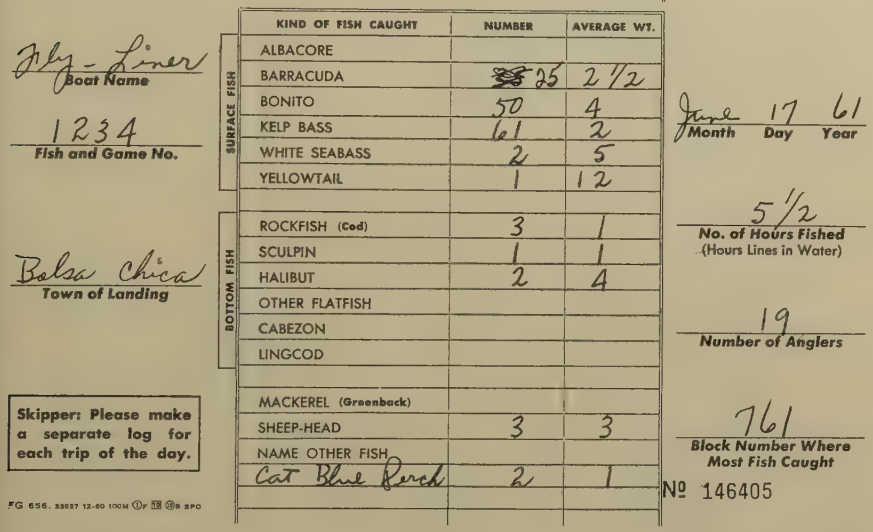
FIGURE 11. Angling regulations are posted on piers, at boat landings, at sporting goods stores, at bait dealers, and on sport boats. Anglers not acquainted with marine species must rely on the skipper for guidance. *Photograph by Jack W. Schott.*

Effective October 1953, the California State Legislature prohibited the sale of kelp, sand, and spotted sand bass and possession of any bass shorter than 10½ inches (Calif. Dept. Fish and Game, 1953). In March 1956, the bass size limit was increased to 11 inches by the California Fish and Game Commission, a five-man body whose members are non-salaried and serve 6-year staggered terms after being appointed by the governor. Increases to 11½ and 12 inches were instituted in March 1957 and March 1959 respectively.

CATCH

INTRODUCTION

In 1935, the California State Legislature enacted laws requring commercial sportboat operators to maintain written records of all fish taken, and empowering the California Fish and Game Commission to prescribe other regulations affecting sport-catch records. Under this authority, the Department of Fish and Game has collected sport-catch records and other data since 1936, excluding World War II years.



Fly-Liner
Boat Name

1234
Fish and Game No.

Bolsa Chica
Town of Landing

	KIND OF FISH CAUGHT	NUMBER	AVERAGE WT.
SURFACE FISH	ALBACORE		
	BARRACUDA	~~25~~	2 1/2
	BONITO	50	4
	KELP BASS	61	2
	WHITE SEABASS	2	5
	YELLOWTAIL	1	12
BOTTOM FISH	ROCKFISH (Cod)	3	1
	SCULPIN	1	1
	HALIBUT	2	4
	OTHER FLATFISH		
	CABEZON		
	LINGCOD		
	MACKEREL (Greenback)		
	SHEEP-HEAD	3	3
	NAME OTHER FISH		
	Cat Blue Perch	2	1

June 17 61
Month Day Year

5 1/2
No. of Hours Fished
(Hours Lines in Water)

19
Number of Anglers

761
Block Number Where Most Fish Caught

Skipper: Please make a separate log for each trip of the day.

FG 656. 33927 12-60 100M

№ 146405

FIGURE 12. An example of the Department's sport-catch log used by the southern California sport-boat fleet. Books of 100 logs are issued as needed.

Each sportboat operator is provided with sport-catch logs (Figure 12) and a fisheries chart (Figure 13), modified to fit conditions encountered in the three broad areas of southern, central, and northern California. There are spaces on the logs to indicate the number of fish landed by species, their average weight, number of anglers, fishing location (fisheries block), date, boat name, boat number, and town of landing. A query as to number of hours fished was added to the log in 1959.

Operators submit completed logs monthly, and each log is inspected by a biologist well-acquainted with the sportboat fishery.

After obvious errors are eliminated, the data are processed and summarized by tabulating machines. The annual catch of kelp bass on sportboats varied from a low of 470,362 in 1956, to a high of 876,667 in 1954 (Table 1). Although sand and spotted bass have been included, they formed only a very small portion of the catch.

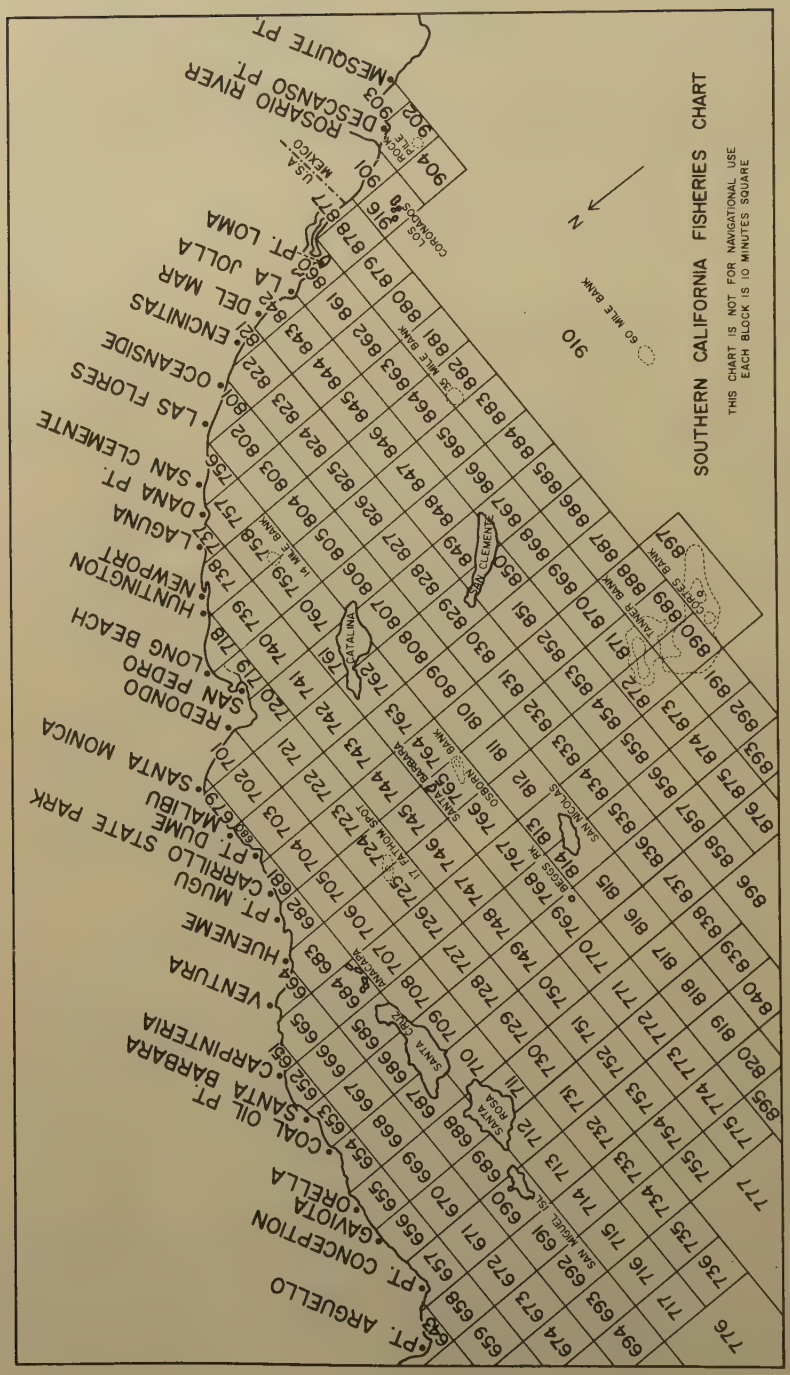


FIGURE 13. The southern California fisheries chart is printed on the inside cover of each log book. Boat skippers report the area number where most or all of their fish were caught.

TABLE 1

Annual Catch of Kelp Bass on Sportboats, 1947-1958

Year	*Number**	*Year*	*Number**
1947	682,789	1953	711,395
1948	630,223	1954	876,667
1949	796,959	1955	497,343
1950	619,397	1956	470,362
1951	781,609	1957	609,071
1952	535,832	1958	653,671

* Includes sand and spotted bass.

During 1947 to 1951, logs from 587 sportboats were compared to the actual catches made by the fishermen (Baxter and Young, 1953). As each boat docked, one member of an inspection team secured the log from the skipper while the catch was being counted by the other members of the team. Boat logs showed 47,878 fish of all species, compared to our dockside count of 46,160, indicating an overestimate of 3.7 percent by boat personnel. The logs showed 17,152 kelp bass, whereas our counts yielded 15,837, an overestimation by vessel personnel of 8.4 percent.

CATCH ANALYSES

Perhaps the most indicative statistical measure of fluctuation in a fishery is the relationship between effort and yield, expressed as fish-per-angler, fish-per-skate, tons-per-haul, and so on.

The straight-forward measurement of angling pressure (effort) should also be examined. Low effort often produces high returns to the fisherman, perhaps presenting an unreliable impression of the fishery's condition. On the other hand, very high angling effort may produce low individual returns while the total catch reaches an unprecedented high.

In addition to fluctuations in effort and yield, the bass fishery is influenced by competing species taken in the same areas and in a similar manner. The relationship between the primary fishery and its competitors must also be measured.

Sport-catch logs have provided the basic data needed to investigate these factors relating to the southern California kelp bass fishery.

Kelp bass catch and fishing effort were influenced by four major elements:

1) To most anglers, bass were desirable but larger game species were preferred when available. (Albacore, unavailable in shallow water, tend to decoy fishermen away from bass grounds.)
2) On certain fishing grounds, bass lacked desirability because of their small size. When bass were small or illegal (bass size regulations were first effective 1953) and large game fish were absent, substitute species were sought, particularly the numerous and easy-to-catch rockfish.
3) Low angling success, all bass sizes considered, brought about lowered effort and substitutes were sought.
4) Bass effort and success was low or non-existent from October through April.

Kelp bass fishing grounds are semi-isolated from one another by geography and fishery practice so data were combined into 12 area

units (Table 2). Only those catches occurring from May through September, 1947 through 1958, were examined. During these five months, bass are at the peak of availability and can compete successfully with other species.

TABLE 2

The Twelve Principal Kelp Bass Fishing Grounds in Southern California and the Fisheries Blocks Included Within Each

	Area	Fisheries blocks
1.	Northern Channel Islands	684-687, 707-710
2.	Point Dume - Malibu Beach	680-682
3.	Santa Monica Bay	679, 701, 702
4.	Rocky Point	720
5.	Horseshoe Kelp	718, 719, 739, 740
6.	Newport Beach - Dana Point	737, 738, 757
7.	San Clemente	756, 801, 802
8.	Oceanside	821, 822
9.	Point Loma - La Jolla	842, 860
10.	The Coronado Islands, Mexico	916
11.	San Clemente Island	829, 849, 850, 867
12.	Santa Catalina Island	760-762, 806, 807

FIGURE 14. Barracuda (left) and bonito are game fish species associated with and affecting the kelp bass catch. *Photo courtesy Davey's Locker, Newport Beach.*

FIGURE 15. Jack mackerel were available and caught in great numbers in 1953, but relatively scarce prior to and since that date. This specimen had been cleaned, causing the body to appear deeper than actual. *Photo courtesy Balboa Pavilion Co., Balboa.*

To determine relative annual contribution percentages, competing species were grouped by class and their catches compared to those of kelp bass.

The two groups are:

I. Game fish. Species commonly taken are barracuda, yellowtail, white seabass, bonito, bluefin tuna *(Thunnus thynnus)*, and jack mackerel (Figures 14 and 15).

II. Incidental and substitute species. In this category, most species were taken incidental to kelp bass and game fish. These included, but were not limited to, Pacific mackerel *(Scomber diego)* (Figure 16), California sheep-head *(Pimelometopon pulchrum)*, sculpin *(Scorpaena guttata)*, white croaker *(Genyonemus lineatus)*, cabezon *(Scorpaenichthys marmoratus)*, giant sea bass *(Stereolepis gigas)*, and shallow-water rockfish. Substitute species were chiefly deep-water rockfish (Figure 17) and California halibut.

FIGURE 16. Pacific mackerel do not attain large sizes, but are extremely vigorous and worthy of an angler's skill. Spinning tackle, as shown here, is used extensively on sport boats. *Photo courtesy Davey's Locker, Newport Beach.*

FIGURE 17. Five chilipepper rockfish *(Sebastodes goodei)* caught on one rod and line. Note the inverted stomachs protruding from the mouths of the two lowermost fish. The plate attached to the rod above the reel is rested on the boat rail for stability while reeling in from the depths fished. *Photo courtesy Pacific Sportfishing Inc., Long Beach.*

Trends in bass angling success and effort were determined by fitting least squares lines to plotted data. Effort plots are in terms of total angler days, May through September. Angling success is shown as bass-per-angler, May through September.

RESULTS

Northern Channel Islands

Boats based at Port Hueneme fished these Islands regularly starting in 1948, but not until 1955 did Santa Barbara field much of a sportfishing fleet. In that year, 10 boats operated from Santa Barbara harbor.

The Northern Channel Islands have proved to be one of the best kelp bass fishing grounds within range of the southern California sportboat fleet. However, it didn't look that way in 1948 when Group II species formed 60 percent of the catch (Appendix 2A).

Kelp bass contributed as little as 32 percent of the May through September catch in 1958 and as much as 75 percent in 1951. For some reason, possibly lack of know-how, bass-per-angler figures were relatively low from 1948 through 1950 (Appendix 1A). Starting in 1951, success varied from 3.8 to 6.6 bass-per-angler, firmly establishing this area as a paying proposition. Warm ocean waters, widely spread during 1957 and 1958, increased the availability of yellowtail, barracuda, and bonito (Radovich, 1961). Prior to 1957, the reported catch of Group I game fish fluctuated from 83 (1948) to 1,349 (1956). In 1957, the game fish catch increased to 14,405 and in 1958 to 24,765. Group II species, chiefly rockfish, provided a larger portion of the total catch from 1955 through 1958 than in the preceding 5 years. But, the appearance of game fish in 1957 and 1958 destroyed the existing competitive relationship between kelp bass and Group II species.

Angling pressure mounted steadily from 1948 through 1958 (Appendix 3A), but showed a tendency to level off at around 20,000 angler days. The best bass catches (Table 3) have been generally associated with the years of greatest effort. However, increased dependence on Group II species from 1955 through 1958, combined with slightly reduced bass angling success, may have been the first signs the bass fishery was reaching a maximum of exploitation.

TABLE 3

Kelp Bass Catch from Sportboats, May-September, 1948-1958, Northern Channel Islands

Year	*Number*	*Year*	*Number*
1948	8,698	1954	86,203
1949	27,741	1955	103,688
1950	33,929	1956	84,939
1951	29,069	1957	105,898
1952	58,466	1958	64,634
1953	54,157		

Point Dume—Malibu Beach

From 1947 through 1958, some of the sportboats fishing the Point Dume-Malibu Beach area often logged certain rockfishes as kelp bass. Yellowtail rockfish (*Sebastodes flavidus*) and olive rockfish (*S. serranoides*) are similar to bass in appearance, are fished in the same way, and inhabit the same places, providing ample opportunity for confusion.

Most boats fishing in blocks 680 to 682 landed their catches at Malibu Beach and Paradise Cove, but Santa Monica and Ocean Park craft also fished these areas.

Kelp bass provided from 6 (1956) to 75 percent (1951) of the total catch (Appendix 2B). The average contribution, 1947 through 1954, was about 49 percent. During 1955 and 1956, bass contributed 6 percent and substitute species 93 percent of the catch. In the 2 warm-water years, 1957 and 1958, bass increased to an average of 29 percent and Group I fishes to 25 and 35 percent, while Group II species decreased to 49 and 32 percent.

Angling effort, never impressive in this area, has shown a slight annual loss trend of 145.5 man days (Appendix 3B).

Success decreased an average of 0.3 bass per-angler-day, 1947 through 1958 (Appendix 1B). The downward trend was constant except for the sharp drop (0.5 and 0.7 bass-per-angler) experienced in 1955 and 1956. The annual bass catch varied between 6,525 in 1955 and 76,714 in 1947 (Table 4).

The statewide kelp bass minimum size limit, first effective in 1953, probably had an effect on the catch, but no measurements are available.

TABLE 4

Kelp Bass Catch from Sportboats, May-September, 1947-1958, Point Dume-Malibu Beach

Year	*Number*	*Year*	*Number*
1947	76,714	1953	34,367
1948	28,559	1954	46,447
1949	72,545	1955	6,525
1950	49,145	1956	8,002
1951	59,308	1957	17,512
1952	36,126	1958	33,050

Santa Monica Bay

Santa Monica Bay was fished by boats from Santa Monica, Ocean Park, Redondo Beach, Malibu Beach, and the Los Angeles-Long Beach Harbor.

Annual sportboat landings of kelp bass in the Santa Monica Bay fishery were low, ranging from 546 in 1956 to 19,773 in 1947 (Table 5). Angler days varied from 7,379 in 1956 to 22,381 in 1948 (Appendix 3C).

Group II species contributed the bulk of the overall catch from 1948 through 1951 and 1954 through 1956. Game fish cut deeply into Group II landings during 1952, 1953, 1957, and 1958 (Appendix 2C).

TABLE 5

Kelp Bass Catch from Sportboats, May-September, 1947-1958, Santa Monica Bay

Year	*Number*	*Year*	*Number*
1947	19,773	1953	13,105
1948	17,237	1954	10,219
1949	18,447	1955	5,164
1950	6,625	1956	546
1951	17,449	1957	12,231
1952	12,948	1958	15,142

Angling success fluctuated widely, ranging from 0.1 to 1.4 bass-per-angler (Appendix 1C). The better catches were in the earlier years.

Santa Monica Bay was not well-endowed with kelp bass during the 12 years of this study and probably had not been for many prior years. Most bass fishing was carried on over sunken wrecks, pier stubs and bottom construction such as sewer pipes.

Rocky Point

The Rocky Point area, fishery block 720, was fished by boats based at Redondo Beach, Santa Monica, Ocean Park, and Los Angeles-Long Beach Harbor. Periodically, Group I species were available at Rocky Point but not at other nearby grounds. At such times, vessels from ports as far away as Newport Beach fished Rocky Point.

Although effort increased an average of 409 angler days each year (Appendix 3D), success decreased by 0.13 bass per-angler-day (Appendix 1D). Group II species gradually increased in relative importance from 1947 through 1954 and rapidly in 1955 and 1956 (Appendix 2D). Game fish were important in the overall catch during 4 years, 1947, 1952, 1957, and 1958. The annual kelp bass catch fluctuated between 9,185 in 1955 and 44,954 in 1949 (Table 6).

Kelp bass were not of primary, nor possibly of secondary importance at Rocky Point. In the best year (1949), 13,000 anglers averaged 3.5 bass, by far the most rewarding season. During the 6 years 1953 through 1958, fishermen averaged approximately 1.1 bass-per-angler-day, too low to be attractive. There is no indication the bass catch can reasonably exceed an average of 25,000 fish from May through September.

TABLE 6

Kelp Bass Catch from Sportboats, May-September, 1947-1958, Rocky Point

Year	*Number*	*Year*	*Number*
1947	28,943	1953	15,441
1948	16,788	1954	28,918
1949	44,954	1955	9,185
1950	19,812	1956	14,927
1951	29,918	1957	26,509
1952	13,894	1958	14,780

Horseshoe Kelp

Horseshoe Kelp has long been one of the most important sportfishing grounds along the southern California coast. Commercial sportboats, private boats, trollers, skiff fishermen, and others congregate there, particularly when barracuda, bonito, yellowtail, jack mackerel and bluefin tuna are in the area (Figure 18). More than 44,000 angler days annually were expended on Horseshoe Kelp during May through September, 1947 through 1958, on sportboats alone (Appendix 3E). Game fish were the big attraction and the number of anglers fishing the area was largely related to the abundance of these fish. As game fish decreased, angler effort decreased an average of approximately 2,400 days-per-year.

Kelp bass fishing success, although not outstanding, remained remarkably stable at about one fish per-angler-day (Appendix 1E). Annual landings varied from a high of 68,967 fish in 1947 to a low of 13,609 in 1955 (Table 7). Rockfish, California halibut and incidental

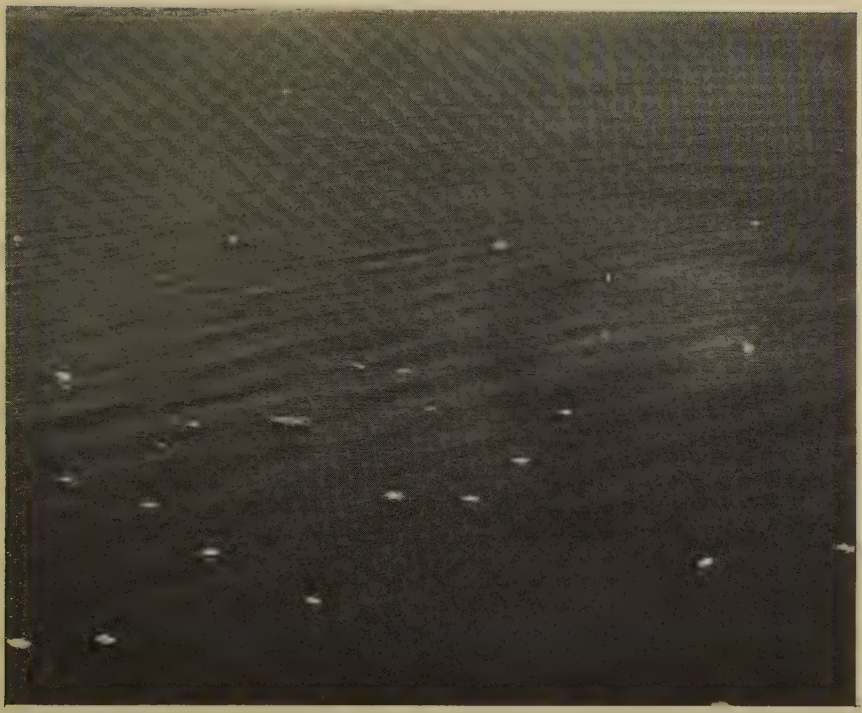


FIGURE 18. There were 50 or more boats fishing Horseshoe Kelp when this photograph was taken, most are two- and three-passenger skiffs. Small craft ring the large boat, taking advantage of its "chumming" superiority. *Dept. of Fish and Game photo by Harry Merrick.*

species contributed an increasing percentage of the catch until 1957 (Appendix 2E).

Many "old timers" fishing Horseshoe Kelp feel the fading of top-floating kelp, occuring prior to 1947 and continuing from then through

TABLE 7

Kelp Bass Catch from Sportboats, May-September, 1947-1958, Horseshoe Kelp

Year	*Number*	*Year*	*Number*
1947	68,967	1953	36,489
1948	48,761	1954	51,482
1949	56,701	1955	13,609
1950	31,388	1956	14,098
1951	22,510	1957	45,265
1952	31,365	1958	42,749

1958, was associated with pollution. Without surface kelp, the area was believed to be less attractive to a variety of fishes.

Clendenning and Sargent (1958) pointed out that giant kelp (*Macrocystis pyrifera*) growth is inhibited by light-absorbing agents in the water. Los Angeles Harbor and the White Point submarine sewer outfall located adjacent to Horseshoe Kelp contribute vast amounts of light-absorbing substances to local waters (Figure 19). Clendenning

FIGURE 19. Opaque mass of polluted harbor water moving seaward with outgoing tide through a 0.4-mile opening in the outer breakwater toward Horseshoe Kelp.
Dept. of Fish and Game photo by Harry Merrick.

and North (1960) commented that kelp had almost disappeared for over 10 miles northward of White Point, but a casual connection between kelp disappearance and operation of the outfall was not established.

Newport Beach-Dana Point

Newport Beach was the center of the southern California marine sportfishery immediately following World War II. From there, in 1947, 117 boats were actively engaged in sportfishing. Their efforts were spread from at least Rocky Point to Oceanside and from Santa Catalina Island to San Clemente Island. Angling effort within the Newport Beach-Dana Point area was not as great as is suggested by the number of boats originating there; it decreased an average of 1,120 days-per-year (Appendix 3F). Despite decreasing effort, fishing success remained almost stable at about one kelp bass-per-man-day (Appendix 1F).

Game fish dominated the catch from 1947 through 1953 (Appendix 2F). Group II species which dominated the catch for the next 3 years, 1954 through 1956, were replaced by game fish during the last 2 years, 1957 and 1958. Although the trend of bass-per-angler-day was slightly upward, catch percentages decreased. During 1947 through 1952, bass

contributed an average of 32 percent but decreased to an average of 23 percent from 1953 through 1958. Annual bass catches fluctuated from 35,791 in 1949 to 13,278 in 1955 (Table 8). Six-year comparisons, 1947 through 1952 and 1953 through 1958, show averages of 28,500 and 24,400 fish respectively.

TABLE 8

Kelp Bass Catch from Sportboats, May-September, 1947-1958, Newport Beach-Dana Point

Year	*Number*	*Year*	*Number*
1947	33,891	1953	27,257
1948	30,064	1954	32,105
1949	35,791	1955	13,278
1950	21,440	1956	15,637
1951	36,166	1957	31,649
1952	14,018	1958	26,738

San Clemente

Much of the angling effort expended in the San Clemente area originated at Newport Beach, although 4 to 13 boats were based at San Clemente proper. When fishing was unprofitable elsewhere, boats from Los Angeles and Long Beach Harbors often were in the San Clemente area. Effort ranged from 21,655 to 52,283 man-days during the 12 years (Appendix 3G). With an annual effort decline 1,148 man-days, angling success also decreased by 0.13 bass-per-angler (Appendix 1G). The average take-home catches ranged from 2.6 bass-per-angler in 1947 to 1.2 in 1958. At the peak of the fishery (1949), 136,415 bass were taken (Table 9).

TABLE 9

Kelp Bass Catch from Sportboats, May-September, 1947-1958, San Clemente

Year	*Number*	*Year*	*Number*
1947	60,515	1953	80,680
1948	105,891	1954	48,103
1949	136,415	1955	30,435
1950	95,062	1956	23,740
1951	87,433	1957	58,293
1952	67,522	1958	43,672

From 1947 through 1953, game fish and kelp bass dominated the catch (Appendix 2G). In 1954 and 1955, Group II species assumed a more important role, actually dominating the catch in 1956. Many anglers stayed home or fished other areas. But in 1957 and 1958, a flood of anglers harvested slightly more bass and substantially more game fish per-man, dropping Group II species to an insignificant position.

Oceanside

Oceanside did not develop extensively as a sportfishing area until 1951. Four to five boats were based here from 1947 through 1950, and 8 to 10 boats from 1951 through 1958. Angler days ranged from 2,887 to 4,884 during 1947 through 1950 and from 7,643 to 16,781 from 1951 through 1958 (Appendix 3H).

Kelp bass and game fish dominated the catch in all years. Peak catches yielded slightly over 50,000 bass in 1951, 1953, 1955 and 1956 (Table 10).

TABLE 10

Kelp Bass Catch from Sportboats, May-September, 1947-1958, Oceanside

Year	*Number*	*Year*	*Number*
1947	13,840	1953	53,520
1948	20,398	1954	36,340
1949	13,052	1955	54,161
1950	13,364	1956	53,113
1951	50,621	1957	41,903
1952	32,469	1958	42,551

Game fish catches averaged about 18,000 annually during 1947 through 1952 and 59,000 from 1953 through 1958. Group II landings were minor, contributing stable percentages until 1958 when more than 16,500 Pacific mackerel were logged during May and June (Appendix 2H).

Success fluctuated between 3.9 and 5.3 bass-per-angler from 1947 through 1955 (Appendix 1H), but from 1956 through 1958, anglers caught 3.4, 2.5, and 2.6 fish-per-man. Lagging catches were probably due to a smaller bass population, more fishermen sharing, and increasing competition from game fish.

FIGURE 20. Birds-eye view of the La Jolla kelp beds, looking southwest toward Point Loma. Lines running through the beds are paths of a kelp harvester.
Photo courtesy Scripps Institution of Oceanography, La Jolla.

FIGURE 21. Fish-eye view of giant kelp.
Photo courtesy Scripps Institution of Oceanography, La Jolla.

Point Loma-La Jolla

San Diego sportboats fished both Point Loma and La Jolla, but expended most effort in the Point Loma section. La Jolla was not called upon to support as much fishing pressure, even though boats from Oceanside and Newport Beach fished there.

From 1947 through 1951, total fishing effort almost doubled, reaching a maximum of 13,326 angler days in 1951 (Appendix 31). The bass population, well-distributed along one of the largest and finest giant kelp beds in California, (Figure 20 and 21) contributed 75 percent of the overall catch (Appendix 21). Individual angler success varied from about 3.0 to more than 4.0 bass-per-man (Appendix 11). As effort continued to increase, eventually reaching almost 26,000 angler-days per year, success fluctuated and in 1957 reached a low of 1.8 bass-per-angler.

Bass catch percentages declined steadily throughout the 12 years, probably from a reduced number of bass, but also because game fish were being landed in increasing quantities. From 1947 through 1951, anglers averaged 1.1 game fish-per-man. During 1952 through 1954 and 1955 through 1958, anglers landed 2.6 and 3.6 game fish-per-man.

In the latter half of 1953, the kelp bass size limit (10½ inches) became effective, but the 1954 catch of 97,253 bass was the greatest on record (Table 11) and effort was also greatest at 25,753 anglers. In 1955, poor catches led to a 55 percent reduction in effort. Game fish

replaced bass to a large extent during 1957 and 1958 but bass yielded 2.9 fish-per-angler in 1958 despite stiff competition of 5.1 game fish-per-angler and a bass size limit of 11½ inches.

TABLE 11

Kelp Bass Catch from Sportboats, May-September, 1947-1958, Point Loma-La Jolla

Year	Number	Year	Number
1947	31,135	1953	70,453
1948	15,732	1954	97,253
1949	27,500	1955	28,641
1950	47,209	1956	42,037
1951	58,589	1957	33,933
1952	42,994	1958	46,105

The Coronado Islands, Mexico

The Coronado Islands were fished by San Diego sportboats. Fishermen were partially subjected to California sportfishing regulations but there were no Mexican regulations to worry about other than licensing (Donald E. Glass, personal communication).

Game fish were apparently the chief target (Appendix 2J) and yellowtail, barracuda and bonito were the most important species. Craig (1960) states, "The Coronados Islands . . . consistently provide the best [yellowtail] fishing" to California sportboats.

An average of 33,000 game fish was landed from 1947 through 1952 compared to a 75,000 average during 1953 through 1958. Because fishing was so productive at the Coronado Islands, anglers flocked to the area, increasing the annual effort by an average of 2,497 man-days (Appendix 3K).

Bass catches were surprisingly low, ranging from 5,096 in 1952 to 45,455 in 1949 (Table 12). As an average, for the 6 years 1947 through 1952, 26,000 anglers caught 24,000 bass. During each of the next 6 years, 1953 through 1958, 16,000 bass were shared by 40,000 anglers. As few as 0.2 bass-per-angler were caught in 1952, 1955, and 1957 and as many as 1.5 in 1949 (Appendix 1J). Logically, bass fishing was best in the earliest years, because stock had accumulated during the war. By 1950, catch and angler success fell sharply, remaining low except for a brief improvement in 1954. In 1953, only 0.8 game fish were caught per-angler, but kelp bass catches did not increase appreciably, failing to fill the void created by low game fish counts. When game fishes are scarce, bass become the primary target if in adequate numbers. It appears bass already were being fished at maximum level, allowing no expansion of the fishery in a time of need.

TABLE 12

Kelp Bass Catch from Sportboats, May-September, 1947-1958, The Coronado Islands

Year	Number	Year	Number
1947	13,140	1953	10,498
1948	42,887	1954	36,235
1949	45,455	1955	8,951
1950	15,165	1956	14,853
1951	23,843	1957	9,368
1952	5,096	1958	14,748

San Clemente Island

San Clemente Island is at the apex of a triangle, the base extending along the mainland from San Diego to Rocky Point. From any port along the base, boats can reach the island and return in 1 day. The shortest distance between the mainland and San Clemente Island is about 46 to 56 nautical miles (53 to 64 statute miles), depending on point of departure. Sportboats from all ports along the base probably have fished the island. Effort at San Clemente Island varied from 335 angler days in 1948 to 23,739 in 1954 (Appendix 3J). The annual bass catch varied from 2,384 in 1948 to 167,535 in 1954 (Table 13).

Angler success remained high throughout the 12 years, 7.6 bass-per-angler in 1947 and 5.6 in 1958 (Appendix 1K). An average annual loss of 0.18 bass-per-angler is shown. Obviously, San Clemente Island was an outstanding bass fishing ground during this period.

Catches of all species (kelp bass, Group I and Group II) ranged from 7.5 to 9.7 during 1947 through 1952 and from 5.9 to 9.0 fish-per-angler during 1953 through 1958 (Appendix 2K). Unlike the Coronado Islands, game fish at San Clemente Island cannot be depended upon to provide a fishery.

Sub-legal bass were not obvious in the San Clemente Island fishery in 1950 (Collyer and Young, 1953), but later observations and casual discussions with sportboat personnel indicated numerous sub-legal bass were present. Size regulations may have restricted individual and total catches during 1954 through 1958.

TABLE 13

Kelp Bass Catch from Sportboats, May-September, 1947-1958, San Clemente Island

Year	Number	Year	Number
1947	6,721	1953	99,679
1948	2,384	1954	167,535
1949	65,193	1955	76,000
1950	38,703	1956	65,712
1951	90,439	1957	59,579
1952	19,231	1958	44,281

Santa Catalina Island

Santa Catalina Island is favored by commercial and sportboat fleets and all types of private craft. It is about 66 nautical miles from Point Loma Light, 26 miles from Newport Beach, and 19 miles from Los Angeles Harbor. The perimeter of the island is dotted with fine fishing spots, harboring many species of fish.

Kelp bass provided about half the sportboat catch from 1947 through 1958, ranging from 36.7 percent in 1958 to 63.7 percent in 1954 (Appendix 2L). In numbers, the catch varied from 65,204 in 1955 to 197,608 in 1947 (Table 14). A poor catch at Santa Catalina Island would have

TABLE 14

Kelp Bass Catch from Sportboats, May-September, 1947-1958, Santa Catalina Island

Year	*Number*	*Year*	*Number*
1947	197,608	1953	129,174
1948	171,292	1954	118,782
1949	140,724	1955	65,204
1950	98,745	1956	66,564
1951	124,293	1957	80,119
1952	97,699	1958	112,586

been excellent elsewhere. Angling effort logged by sportboats was only a portion of the total effort expended. Sportboat anglers ranged from 24,830 in 1957 to 81,245 in 1951 (Appendix 3L). A sharp decline in angler success was evident from 1947 through 1953 (Appendix 1L), but under reduced fishing pressure and notwithstanding size regulations, the catch of bass-per-angler improved from 1954 through 1958.

Although effort fell off sharply beginning in 1954, landings of Group II species remained relatively constant. Catches ranged from 29,700 to 58,500 during 1947 through 1952 and from 20,500 to 52,600 during 1953 through 1958. They averaged 41,600 from 1947 through 1952 and 40,600 from 1953 through 1958. Group I game fish ranged from 109,000 to 183,000 during 1947 through 1950; from 47,000 to 83,000 during 1951 through 1953; from 17,000 to 25,000 during 1954 through 1957; and were 173,000 in 1958. Evidently percentage variations in the catch reflected losses of kelp bass and fluctuating abundance of game fish, rather than an increase in substitute-incidental fishes. Sub-legal bass were numerous in 1950 and 1952 (Collyer and Young, 1953). The size regulation probably restrained the catch considerably; however, 80,000 and 112,000 bass were landed in 1957 and 1958, an average of 3.2 and 2.6 bass-per-angler.

RELATIONSHIP OF CATCH TO TEMPERATURE

The kelp bass population in each of the 12 areas is believed to be largely independent. Bass abundance is a function of the extent and natural productivity of each area. Thus, between areas, there are wide differences in density and sustained yield (Table 15). Temperature was also a factor in bass fishing success.

TABLE 15

Total Angler Days, Bass, and Bass-Per-Angler by Area, May-September, 1947-1958, Ranked by Angler Days

Area	*Total angler days*	*Total bass*	*Bass-per-angler*
Santa Catalina Island	677,213	1,402,790	2.1
Horseshoe Kelp	531,908	463,384	.9
San Clemente	428,054	837,761	2.0
The Coronado Islands	398,755	240,239	.6
Newport Beach-Dana Point	297,658	318,034	1.1
Rocky Point	181,898	264,069	1.5
Santa Monica Bay	179,768	148,886	.8
Point Loma-La Jolla	170,484	541,581	3.2
Point Dume-Malibu Beach	156,356	468,300	3.0
North Channel Islands	143,367	657,422	4.6
Oceanside	114,102	425,332	3.7
San Clemente Island	113,913	735,457	6.5

Although the kelp bass size limitation became effective in 1953, during the first full season under a size limit (1954), outstanding bass catches were made in 8 of the 12 areas. The Northern Channel Islands yielded their highest recorded bass catch-per-angler. At Rocky Point, Horseshoe Kelp, Point Loma-La Jolla, and San Clemente Island, record or near-record catches were made. At Santa Catalina Island, with half as many anglers as recorded in 1953, 1954 bass totals were only 8 percent lower. The statewide bass catch, 876,667 fish (Table 1), was the greatest on record.

Ocean temperature records compiled at Scripps Pier, La Jolla, showed that the water was warmer in 1954 (approximately 16.9° C [62.4° F] average of monthly mean sea-surface temperatures), than in any of the previous 6 or following 2 years (Radovich, 1961).

Water temperatures were well over the 16.9° C mean in 1957 and 1958, but for various reasons bass catches were not outstanding. Statewide totals were 609,000 in 1957 and 654,000 in 1958; the 12-year average was 655,000.

At the Northern Channel Islands, 1957 was the best year on record for total bass (105,898) and ranked well up in success with 5.1 bass-per-angler. In 1958, game fish reached the islands in unprecedented numbers and were eagerly sought, making bass a secondary choice. Anglers landed almost 25,000 game fish, where hundreds had been considered normal prior to 1957.

At Horseshoe Kelp, good catches of 45,000 and 43,000 bass were landed in 1957 and 1958, not as high as in 1954 but about three times better than cold-water years 1955 and 1956. The bass-per-angler figure for 1957 and 1958 was about equal with 1954 and twice as good as 1955 and 1956.

Bass-per-angler at San Clemente remained stable during 1957 and 1958 despite a heavy influx of game fish and almost double the angling pressure reported in the previous 2 years.

Game fish catches at Point Loma-La Jolla during 1957 and 1958 were the highest on record. Bass-per-angler figures remained about stable.

At Santa Catalina Island in 1957 and 1958, the bass catch was much higher than in 1955 or 1956, but less than in 1954. However, bass-per-angler figures were among the best, while angler pressure averaged out about the same as in 1955 and 1956. Significantly, game fishing was poor in 1957, hence 3.2 bass-per-angler, and excellent in 1958 (173,000 fish) when 2.6 bass-per-angler were taken.

Radovich (1961) discussed changes in the distribution of many marine species during 1957 through 1959, including yellowtail and barracuda. He conclusively demonstrated that these changes were associated with increased water temperatures. In many areas, resident kelp bass were caught in significantly greater numbers during 1954, 1957 and 1958. Ocean temperature records (Scripps Institution of Oceanography, 1958) show 1954 was the warmest year (mean annual temperature 16.86° C) between 1947 (16.88° C) and 1957 (17.35° C).

TAGGING

Approximately 400 kelp and sand bass were tagged and released in Baja California, as far south as Abreojos Point. No bass tagged in Mexico has been recovered in California (Collyer and Young, 1953).

Kelp bass are tough, easily enduring the rigors of tagging and handling. When taking a bait, bass often swallowed the hook and created a problem of removing it without killing the fish. In 39 cases, the leader was cut leaving the hook in place. Seven of these fish (18 percent) subsequently were recovered.

MATERIALS AND METHODS

Collyer and Young (1953) presented a discussion of tagging methods and materials and nothing has changed since then. All tags, except for approximately 100 "spaghetti" tags (Wilson, 1953), were Petersen disks. Silver wire, stainless steel pins and monofilament nylon were used to attach tags (Figures 22 and 23). Monofilament nylon was more reliable than either silver or stainless wire (Young, Schott and Collyer, 1953).

FIGURE 22. Petersen disk fish tag with silver wire pin. *Photograph by Jack W. Schott.*

A California spaghetti tag remained in place 1,053 days and a Petersen disk attached with monofilament nylon was recovered after 1,036 days.

During 1950 and 1951, kelp bass were tagged from the decks of numerous sport boats (Figure 24). In some instances, all bass caught were tagged and at other times only those caught by biologists and boat personnel were used. In 1952, only a few of the bass tagged were

FIGURE 23 Petersen disk fish tag with monofilament nylon pin. Photograph by Jack W. Schott.

FIGURE 24 Tying the finish knot in monofilament nylon. Bass often picked this moment for a convulsive leap, burying one or more spines in vulnerable hands.

taken on sportfishing boats, most were trapped. The best of two types of traps was a cylinder, 4 feet in diameter and 22 inches high, covered with 1-inch hexagonal poultry netting (Figure 29). The second was a much lighter cylinder 22 inches in diameter and 36 inches long with a single fyke at one end. The larger trap was fished on the bottom while the smaller was suspended above the bottom at varying distances (Collyer and Young, 1953). In 795 lifts, at La Jolla, 2,181 fish, crustaceans, mollusks and echinoderms were captured. Among the more important and unusual species were 854 lobsters *(Panulirus interruptus)*, 735 kelp bass, 78 California morays *(Gymnothorax mordax)*, 113 perches (family Embiotocidae), 63 sculpins, 25 sheep-heads, 22 cabezons, 10 round stingrays *(Urolophus halleri)*, and 1 bird, a cormorant *(Phalacrocorax* sp.).

LOCALITIES

Tagging in California was carried on from Point Loma north to Santa Cruz Island, but predominately in areas of heaviest fishing (Table 16).

TABLE 16
Dates and Areas of Release for 5,817 Tagged Kelp Bass, 1950-1957

	Number Released by Year								
Area	*1950*	*1951*	*1952*	*1953*	*1954*	*1955*	*1956*	*1957*	*Total*
Santa Catalina Island	381	67	1,085	773	--	22	--	4	2,332
Pt. Loma-La Jolla	311	13	955	546	--	--	7	--	1,832
San Clemente	310	108	3	--	--	--	--	--	421
San Clemente Island	235	37	3	--	--	69	--	--	344
Pt. Dume-Malibu Beach	22	15	--	--	262	--	--	--	299
Santa Cruz Island	93	117	--	--	--	--	--	--	210
Horseshoe Kelp	1	6	--	121	--	--	--	--	128
Oceanside, (Encinitas)	90	--	--	--	--	--	--	--	90
Santa Barbara Island	49	--	--	--	--	--	--	--	49
Newport Beach-Dana Pt.	13	30	4	--	--	--	--	--	47
Rocky Point	--	--	--	33	--	--	--	--	33
San Nicolas Island	--	19	--	--	--	--	--	--	19
Santa Monica Bay	9	4	--	--	--	--	--	--	13
Total	1,514	416	2,050	1,473	262	91	7	4	5,817

RECOVERIES

Most tag recoveries were by anglers on sportboats and barges. Bass were occasionally recovered by our own personnel only hours after tagging. Commercial fishermen, working other fish species, recovered a few tagged bass.

Approximately 50 percent of 956 tag recoveries were made within 2 months and 68 percent within 6 months (Table 17). Probably there would have been more recoveries if monofilament nylon had been used for tag attachment throughout the program.

TABLE 17
Number and Percent of Tags Recovered in Consecutive Time Periods Following Release, 1950-1957

	Months at liberty					*No*	
	0-2	*2-6*	*6-12*	*12-24*	*24+*	*data*	*Total*
Number Recovered	507	147	196	42	4	60	956
Percent Recovered	53.0	15.4	20.5	4.4	--	6.3	99.6

Recoveries depended upon the kind of attachment material, the time of year tagging took place, and the release location. Releases early in the year increased chances for short-time recoveries. Fish released late in the year had a better chance to overwinter, delaying recoveries. For example, 331 kelp bass caught at San Clemente Island were transported to Hen Rock, Santa Catalina Island to test homing tendencies. At Santa Catalina Island, the bass were tagged and released on November 5, 1953. The first recovery was made on March 14, 1954, more than 4 months after release. Subsequently, 89 (27 percent) of the transplanted bass were recovered, all at Santa Catalina Island. On the other hand, 344 San Clemente Island bass, tagged and released on their home grounds, yielded 15.7 percent recoveries (Table 18), illustrating one effect of release locality on tag recoveries.

TABLE 18

Kelp Bass Tag Recoveries by Area, 1950-1957

Area	*Number tagged*	*Number recovered*	*Percent recovered*
Santa Catalina Island	2,332	433	18.6
Pt. Loma-La Jolla	1,832	225	12.3
San Clemente	421	127	30.2
San Clemente Island	344	54	15.7
Pt. Dume-Malibu Beach	299	44	14.7
Santa Cruz Island	210	1	–
Horseshoe Kelp	128	25	19.5
Oceanside (Encinitas)	90	14	15.6
Santa Barbara Island	49	3	6.1
Newport Beach-Dana Point	47	13	27.7
Rocky Point	33	14	42.4
San Nicolas Island	19	–	–
Santa Monica Bay	13	3	23.1
Total	5,817	956	16.4

MOVEMENTS

Collyer and Young (1953) noted 16 kelp bass had moved 5 or more miles and 23 had traveled from a few hundred yards to 4 miles. More than 400 bass recovered in Mexico and California showed no movement. Several boat skippers have described what they believed were schools of traveling kelp bass well offshore over deep water. Their attempts to fish the schools were moderately successful, and all bass caught were large.

An unknown but probably very small number of movements was caused by fishermen. Tagged bass, upon recovery, were often placed alive in the boat's bait tank for safekeeping. Often these were forgotten and were inadvertently released when the live-bait was jettisoned at day's end. One bass, recovered at Santa Catalina Island, was transported to Newport Beach and released.

Records of kelp bass movements have been extracted from data showing fish length, distance traveled, and time interval between tagging and recovery. Some tag recoveries showing movement, or lack of it, have been omitted because data were incomplete (Table 19). Thirty-two tagged kelp bass moved 5 or more miles during 1952 through 1957 and 62 bass traveled distances up to 5 miles. An additional 364 were recovered at the release locality. Overall, approximately 20 percent of the recovered fish had moved recognizable distances.

TABLE 19

Kelp Bass Movements by Fish Length Based Upon Tag Recoveries, 1952-1957 *

Miles traveled	*Length in inches at tagging*				
	5.9–10	*10–12*	*12–15*	*15–21.1*	*Total*
0	201	94	42	27	364
.1–5	30	14	14	4	62
5–10	10	2	1	1	14
10–25	6	2	1	–	9
25–282	4	4	1	–	9
Totals	251	116	59	32	458

* Returns from transplated bass (San Clemente Island to Santa Catalina Island) not included.

There is no indication that length of fish is correlated with movement. Chance alone can account for whatever small differences exist between size groups.

Fourteen of the 32 bass moving 5 or more miles, moved from one fishing area to another (Table 20). Two bass released in the Point Dume-Malibu Beach area moved downcoast. One was caught at the Los Angeles Harbor breakwater 9 months after tagging, the second at Rocky Point almost 3 years after release. One bass moved from Rocky Point to the Los Angeles Harbor breakwater in 3 months, another from

TABLE 20

Kelp Bass Moving from Area to Area

Release area	*Recovery area*	*Miles traveled*	*Length at tagging inches*	*Tagged interval months-days*
Point Dume-Malibu Beach	Rocky Point	30	11.8	34– 3
Point Dume-Malibu Beach	Horseshoe Kelp	45	12.4	8–28
Rocky Point	Horseshoe Kelp	10	12.2	3– 1
Horseshoe Kelp	Rocky Point	15	13.8	–10
Point Loma-La Jolla	Rocky Point	80	10.6	22– 6
Point Loma-La Jolla	San Clemente	25	11.0	1– 9
Point Loma-La Jolla	San Clemente	33	10.2	10– 0
Point Loma-La Jolla	Oceanside	12	9.7	10–19
Point Loma-La Jolla	Oceanside	14	11.6	10–13
Point Loma-La Jolla	San Benito Isl., Baja Cal.	282	6.9	17– 5
Santa Catalina Island	Point Dume-Malibu Beach	40	9.7	1– 8
Santa Catalina Island	Point Dume-Malibu Beach	50	11.4	16–22
Santa Catalina Island	Rocky Point	20	9.3	2–19
Santa Catalina Island	Newport Beach-Dana Point	32	9.1	–20

Horseshoe Kelp to Rocky Point in 10 days. Six La Jolla-Point Loma bass moved to other areas: one 7-inch fish was recovered at San Benito Island, Baja California, after 17 months; two were recovered in the Oceanside area, both after 10 months liberty; two were caught in the San Clemente area, 1 and 10 months later; and one was recovered off Rocky Point in 22 months. Four Santa Catalina Island bass were recovered in mainland areas: two at Point Dume 1 and 17 months later; one at Rocky Point in approximately 3 months; and one at Newport Beach-Dana Point in 20 days.

None of the San Clemente Island transplants is known to have returned to its place of origin, or moved to any other area (Table 21). However, approximately 83 percent of the recovered fish moved to some extent and eight of the transplanted fish were returned without data as to movements. Although more of the transplanted bass traveled than did resident bass, the distances involved were not significant. Only 4 of 81 bass moved 10 or more miles.

TABLE 21

Movements of 81 Kelp Bass Transplanted from San Clemente Island to Santa Catalina Island, November 1953

Miles traveled	*Length in inches at tagging*			
	10-12	*12-15*	*15+*	*Total*
0	10	4		14
.1-5	26	26	1	53
5-10	7	2	1	10
10-25	2	1	1	4
Totals	45	33	3	81

LIFE HISTORY

INTRODUCTION

The marine sportfish investigation, starting in 1946, was required to place primary emphasis on the sportcatch log system (Baxter and Young, 1953). By 1949, it was apparent biological facts were needed to complement the statistical picture. Walford (1932) had published a report on the life history of the California barracuda, Clark (1931) discussed aspects of the life and commercial catch of California halibut, and Whitehead (1930) discussed the commercial white seabass fishery. The only detailed catch and biological data pertaining to the omnipresent and assertive kelp bass were two short papers by Clark (1933, 1936).

The kelp bass life history, as it relates to the fishery, has been pieced together over a period of years, starting with tagging in 1950 and ending with a brief investigation in 1960 to determine whether or not hermaphroditism existed as it does in many other members of the family Serranidae.

GROWTH

Because only 1 of the 81 tagged kelp bass recoveries used in the growth study (Table 22) was at liberty exactly 1 year (365 days), each of the remaining 80 growth records was converted to growth-per-

TABLE 22

Eighty-One Kelp Bass Tag Recoveries Showing Growth, Grouped by Length

Length at tagging inches	*Number of kelp bass*	*Percent*	*Length at tagging inches*	*Number of kelp bass*	*Percent*
7	13	16.0	13	4	4.9
8	20	24.7	14	5	6.2
9	14	17.3	16	1	1.2
10	9	11.1	17	2	2.5
11	9	11.1	21	1	1.2
12	3	3.7			

day by dividing total growth increment by the number of days the fish was at liberty. This growth-per-day figure, when multiplied by 365, yielded the calculated growth-per-year. A straight line fitted to the plotted data ($Y = 2.94 + .857\ X$), length at tagging against calculated length a year later (Walford, 1946), shows the average attained length in a year's time (Figure 25).

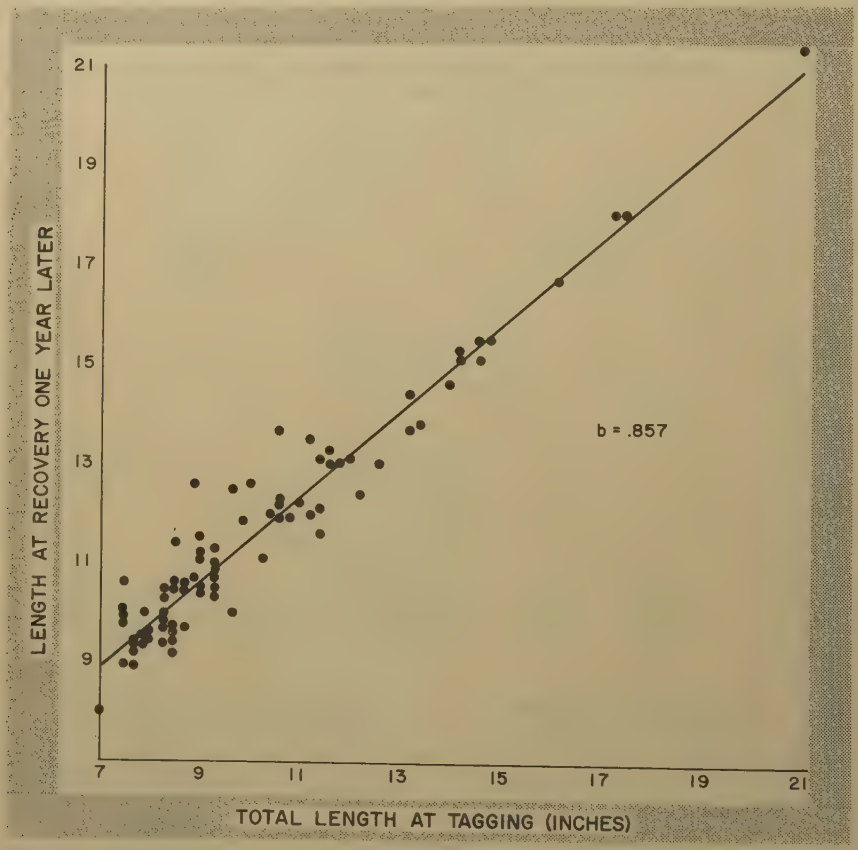


FIGURE 25. Kelp bass growth based on length increases of 81 tagged fish.

Although the growth data were derived entirely from bass that were 7 to 21 inches long when tagged, it may be assumed growth rates would be similar for larger and smaller fish. Actually, however, bass probably grow at a faster rate during their first year of life. Growth rates obtained through tag return data are generally considered minimal because of the handling and injury involved in the tagging process. Annual growth of bass 7 to 15 inches long can be estimated by the formula: $2.94 - .143X$. In this equation, the quantity X equals fish length at the start of a year. Thus a 7-inch fish would grow 1.94 inches in 1 year (2.94 inches minus .143 inches times 7 inches equals 1.94 inches). As a fish's length increases, its annual increment decreases (Table 23). Based on the above formula, the theoretical average

FIGURE 26. This 14-pound 9-ounce kelp bass is the largest ever examined at the California State Fisheries Laboratory. Captain Albert Dixon of the bait boat *Ercyl D.* picked it up from the surface of Newport Bay during the dark of night. Its actions suggested it was disabled or dying. *Photograph by John L. Baxter.*

maximum length of a kelp bass is about 20.5 inches. Much longer fish have been observed in the field many times.

Growth criteria of kelp bass we collected for age-length studies resemble those from tag returns. Mean length at age X was plotted against mean length 1 year later, Y, and the straight line formula fitted to these data was $Y = 2.47 + .913X$. An estimate of the annual growth increment for bass between 4 and 15 inches long can be determined by solving for X in: $2.47 - .087X$. Although no attempt is made statistically to compare the growth parameters of tag return

TABLE 23

Expected Annual Growth Increments of Kelp Bass of Differing Lengths Based on Tag Recoveries

Total length inches	*Average growth increment in one year*	*Average total length*
7	1.94	8.94
8	1.80	9.80
9	1.65	10.65
10	1.51	11.51
11	1.37	12.37
12	1.22	13.22
13	1.08	14.08
14	.94	14.94
15	.79	15.79

and age-length kelp bass, each supports the other generally, particularly for bass 7 to 15 inches long. Growth increments for tagged fish of these sizes ranged from 1.94 to 0.8 inches, whereas age-length bass grew 1.86 to 1.16 inches in the same size range.

Theoretical average maximum bass length by the age-length formula is 28.4 inches. Five bull bass caught off the Newport jetty during 1960 and 1961 were 27 to 28.4 inches long and weighed from 8 pounds 11 ounces to 10 pounds and 3 ounces (Robert Bailey, pers. commun.). A 14-pound 9-ounce bass collected by the bait boat *Ercyl D* in October 1960 was 27.4 inches long (Figure 26).

AGE

Age determinations were made from scales of 432 kelp bass collected from April through October over a period of several years at almost every major sportfishing area in southern California (Table 24). Although otoliths were removed from many kelp bass, we did not use them in our age work because we did not feel we could devote enough time to interpret their markings properly. Besides, scales

TABLE 24

Ages of 432 Kelp Bass as Determined from Scales

Age	*Length-range mm*	*Mean-length inches*	*Number aged*
1	70-139	4.03	25
2	120-239	6.06	27
3	170-259	8.59	72
4	210-299	10.11	96
5	240-369	11.37	67
6	280-369	12.40	59
7	310-379	13.49	31
8	330-419	14.52	20
9	400-449	16.55	12
10	390-449		3
11	390-489		8
12	460-509		4
13	450-509		4
14	500-529		2
15	515-		1
16	516-		1

seemed both reliable and adequate and they were easy to remove and store.

All fish were measured from the tip of the snout to the extreme tip of the longest caudal ray; sex, time, and place of capture were also recorded. Scales posterior to the insertion of the pectoral fin were best for age determination, but had to be selected with care to avoid regenerated ones, particularly prevalent on older and larger fish. In some instances, scales had to be taken from other areas of the body. Six scales from each fish were mounted dry between glass slides. Glycerin jelly was rejected as a mounting medium because it frequently cracked and destroyed otherwise acceptable scale clarity. True annuli could be traced around the entire scale. Circuli laid down after the resumption of growth in the spring showed "cut over" areas (Beckman, 1943). Nearly all scales from fish taken late in October had crowded marginal circuli, whereas those taken in April showed more

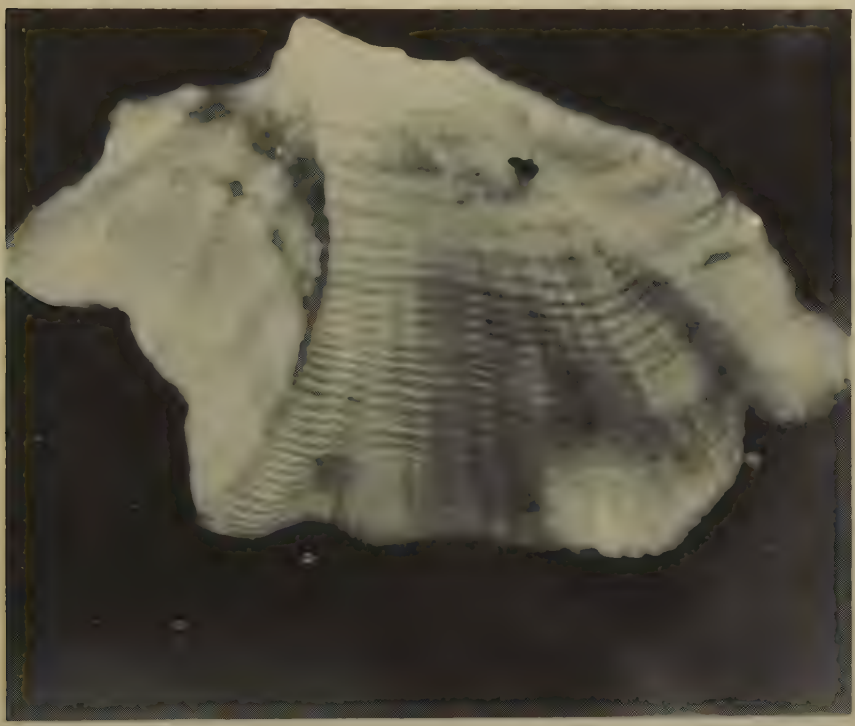


FIGURE 27. A .012 inch section of an otolith (earbone) from a 32-year-old kelp "bull" bass (discovered to be a female). The annular winter rings are widely spaced at the top, becoming closer together as the fish aged and annual increment diminished.
Photomicrograph by Jack W. Schott.

widely-spaced circuli (Creaser, 1926). Evidently, the annuli of the fish examined in this study were laid down somewhere between October and April. Twenty kelp bass ranging from 78 to 113 mm total length (mean length 99.9 mm) collected in April 1955 at San Clemente and Santa Catalina Islands had one ring. Usually one or two widely-spaced

circuli were present on the scale perimeter. After 6 to 8 years, the scales were thickened and it was difficult to see annual rings, including those deposited earlier in life (Creaser, 1926).

Kelp bass are believed to reach a ripe old-age. A relatively slow growth rate and eventual large size tends to confirm this impression. Thirty-two annuli were counted on a thin section of an otolith from a 14-pound 9-ounce bass (Figure 27). Hinton (1962) reported a kelp bass lived 12 years in the Scripps Institution of Oceanography aquarium. No mention was made of its probable age when introduced into the aquarium.

WEIGHT-LENGTH RELATIONSHIP

The kelp bass weight-length relationship was calculated with data from 356 fish collected from as many fishing areas as possible during April through October and included fish in all stages of sexual development (Figure 28). Total lengths were measured to the nearest

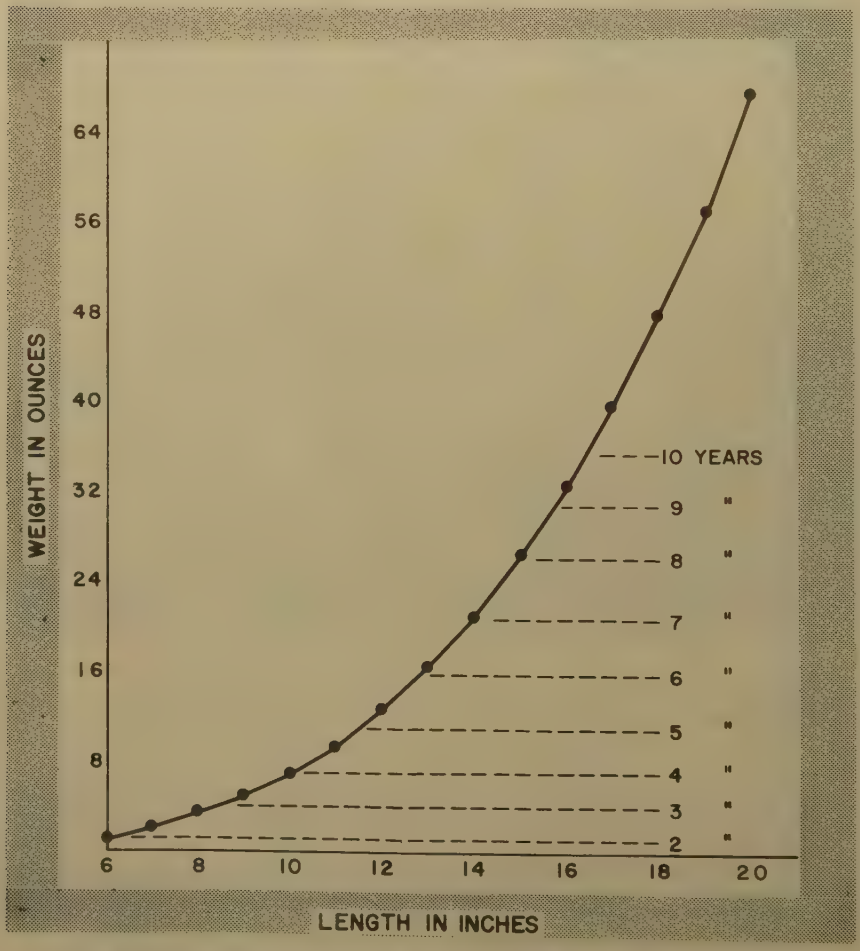


FIGURE 28. Kelp bass weight-length relationship (356 fish) with approximate age.

millimeter and weights recorded to the nearest gram. These data were later converted to inches and ounces. The equation: $W = 0.00376L^{3.27}$ was obtained following the method given by Rounsefell and Everhart (1953).

The largest bass in the weight-length sample was 22.5 inches long and weighed 100 ounces (6.25 pounds).

FOOD

The stomachs of 99 kelp bass, collected at San Clemente and Santa Catalina Islands in April 1955, were examined for food. No quantitative study was attempted but an effort was made to identify all items found in these stomachs and to determine which were the most important. Forty small bass, 3.0 to 7.5 inches long, were caught in fish traps near Long Point, Santa Catalina Island (Figure 29). The most important food items in their stomachs were very small, $\frac{1}{8}$- to $\frac{1}{4}$-inch long, amphipods and decapod shrimp. In lesser numbers were caprellids, euphausiids, brachyurans, anchovies, and unidentified fish remains. Only one of these 40 bass had an empty stomach.

FIGURE 29. Kelp bass from 3 to 7½ inches long were caught in a 4-foot wire trap covered with fine mesh cotton webbing. The webbing was installed on the foredeck of the Department of Fish and Game vessel *N. B. Scofield.*

In 59 stomachs from bass longer than 8 inches, small crustaceans were very important. Fish were found in the stomachs of the larger bass oftener than in the small bass. Anchovies were the only fish food identified but remains of unidentified fish were found. Tunicates,

atherinid eggs, abalones *(Haliotis* spp.), mole crabs *(Blepharopoda occidentalis)*, sea hares *(Aplysia* spp.), and small brachyuran crabs were also found. Apparently small crustaceans are important food for kelp bass of all sizes, with fish becoming prevalent in the stomachs of larger bass. Large bass examined in the field had eaten squids, octopuses, shiner perch *(Cymatogaster aggregata)*, other embiotocid perch, anchovies (probably bait), queenfish *(Seriphus politus)*, small rockfish, and clam siphon tips. Quast (n.d.) examined approximately 1,700 kelp bass stomachs and found that, "In general individuals shift from demersal crustacea to larger, more motile, prey, such as fish and cephalopods, with growth."

MATURITY

Collyer and Young (1953) determined that maturation occurs as early as April for bass 325 mm long and longer. In June, fish as small as 201 mm were mature. By September and October, some fish 200 mm long and longer, had completed the maturation cycle. Quast (n.d.) found first maturity occurred at approximately 178 mm and spawning was completed much earlier in the year for smaller fishes. His data suggest a second spawning for the largest females.

Hermaphroditism

Hermaphroditism has been found in serranid fishes on the American side of the Atlantic (Lavenda, 1949; Smith, 1959). Atlantic sea bass *(Centropristes striatus)* are predominantly females when young but gradually change sex until their 10th year, after which they are all males. Males live for at least an additional 10 years.

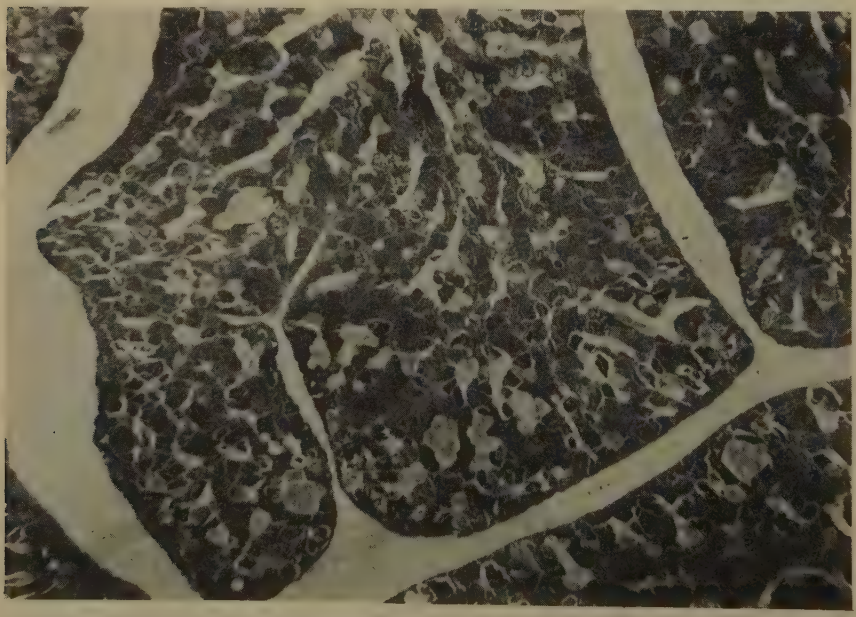


FIGURE 30. Section from the gonad of a 246 mm male kelp bass. Partial voiding of the spermia is indicated by numerous patches of light gray in the dark tissue.
Photomicrograph by Jack W. Schott.

Gonads were examined from 42 male kelp bass, ranging from 217 to 507 mm, and 23 females, 204 to 430 mm total length, collected with hook and line at Santa Catalina Island and San Clemente in June 1960. These had been removed immediately, wrapped in gauze, and fixed in 10 percent formalin. Quarter-inch cubes of the material were stained with hematoxylin and eosine, sectioned, and mounted on slides (Figures 30 and 31). The sections were examined under a stereoscope at 6.3 to 40 diameters. All stages of development were encountered, ranging from an immature female (204 mm) to complete voiding of germinal cells in a 266 mm male. In one instance only, ovarian tissue appeared to be an integral part of a male gonad, but could have been deposited during laboratory processing of the study material.

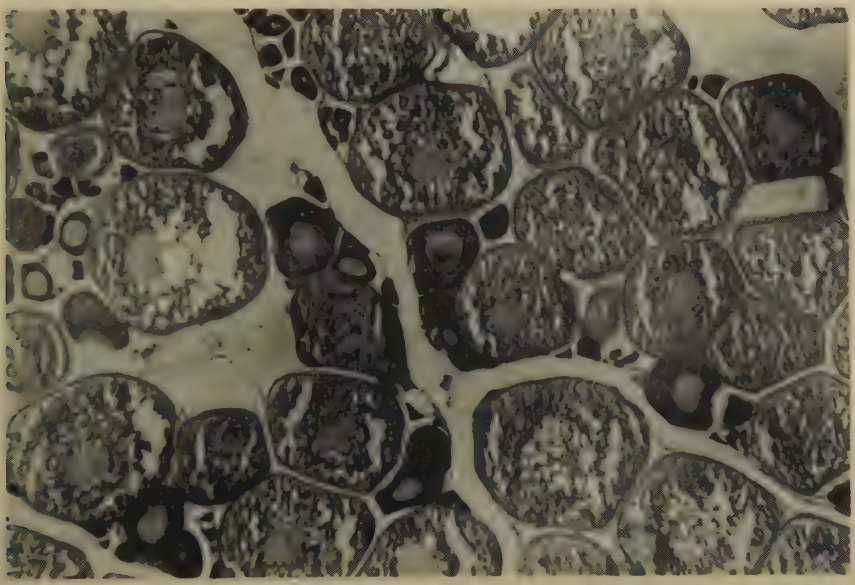


FIGURE 31. Various stages in the development of egg cells in a 320 mm kelp bass. Many of the large cells are mature or nearly so. At least one egg had escaped (left-center of photo). *Photomicrograph by Jack W. Schott.*

DISCUSSION

CATCH

Following World War II, the Point Dume-Malibu Beach area appeared to be well-stocked with bass but the population did not approach the size of populations found in many other areas. Moderate fishing pressure created shortages of large fish. As a result, the 10½-inch size limit imposed a severe handicap on the angler, and he was forced to accept substitute species. Catch and angler success recovered slightly in 1957 and 1958 but warmer waters may have been the primary stimulus.

Bass at the Horseshoe Kelp area were mostly large, and small fish were noticeably lacking, suggesting the area is not a nursery. However, there is some possibility pollution may have altered the Horseshoe Kelp area enough to render it unproductive as a nursery, but not enough to eliminate a fishery for adults. Some of the large bass might be year-around residents, but some probably straggle in from Rocky Point and Los Angeles Harbor breakwater. In the absence of small fish, angler success has been relatively low.

The Newport Beach-Dana Point area was fished consistently during the war. As a result, bass angling failed to show the high returns in 1947 experienced elsewhere and gradually diminished as the years rolled by. The total number of bass in the population must have been well below the area's potential because the average catch of 1.1 bass-per-angler over the 12 years was the lowest return in any of six mainland areas similar in extent and habitat.

Effort and catch at San Clemente remained relatively high from 1947 through 1953, but it appears the size limit delivered a hard blow for the next 3 years. This situation was not surprising, as a high proportion of the bass taken as early as 1950 were between 6 and 11 inches long (Collyer and Young, 1953). This area, as well as Point Loma-La Jolla produce tremendous numbers of bass, constituting what appears to be an ideal nursery ground containing relatively few large bass. The fishery eventually will be harvesting this abundant crop, but the full impact may not be felt until several years after the 12-inch size regulation has been in effect.

Low exploitation of the bass fishery in the Oceanside area for the 4 years 1947 through 1950, did not alter its population structure very much. Even though intensity tripled during the next 4 years, angler success remained constant but the heavy catches began to have a telling effect. Field observations showed fewer large bass but there was a generous distribution of 12- and 13-inch fish. In general, 1955 marked the last year of top-notch catches.

The bass size limit probably had no tangible effect until it was raised to 11 inches in 1956. Raising the limit to 11½ inches in 1957 plus an incursion of game fish further lowered bass catches, but it is not possible to estimate total effect.

MORTALITY

The final objective of a fishery investigation is to delineate and manage the factors affecting catch, to arrive at a maximum sustained yield. Examination of total catch and effort data, in great volume, may determine the range of effort needed to attain maximum sustained yield. But, total catch and effort are not known in the bass fishery, furthermore they are unobtainable because bass fishing is only part of a much larger sportfishery. Perhaps San Clemente Island alone, isolated and predominately a bass fishery, could be managed for maximum yield on the basis of known effort.

Changes in population size and yield are associated with natural as well as fishing mortality. Having examined the effect of fishing at the 12 principal kelp bass grounds, data on natural mortality were explored.

The natural mortality rate was computed from a sample of 293 kelp bass collected at the relatively unfished San Clemente, Santa Cruz, and Santa Barbara Islands in 1950. Total lengths ranged from 345 to 520 mm and ages of 7 to 13 years were assigned by the age at length formula. Ages above and below 7 to 13 were not included for lack of fish. Frequencies at each age were converted to logarithms and ranged along the X-axis. The formula $Y = 4.72 - .287\,X$ was obtained for the line fitted to the data (Figure 32). The natural mortality rate was estimated

$$\begin{aligned} 1 - e^{b} &= 1 - e^{-.287} \\ &= 1 - .75 \\ &= .25 \text{ or } 25\% \end{aligned}$$

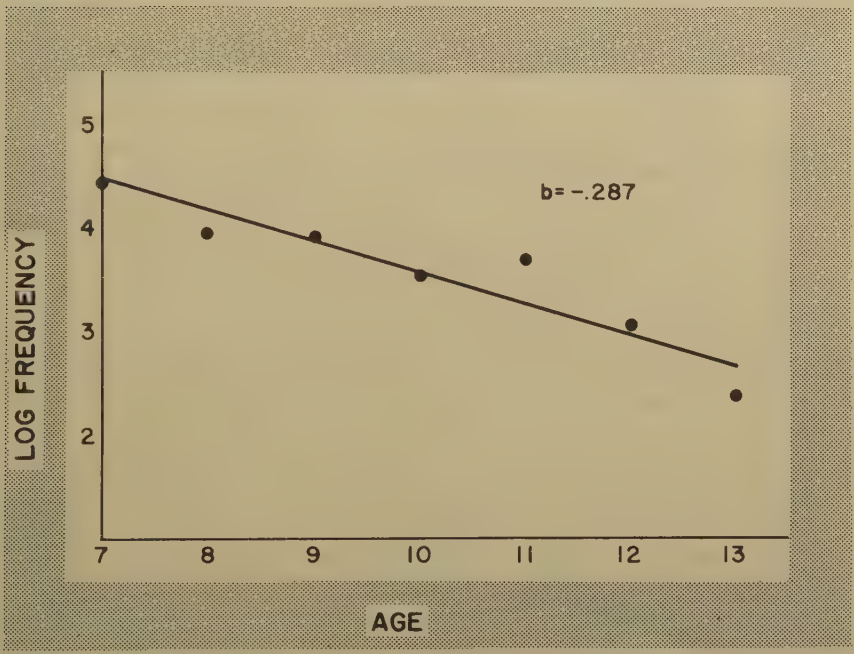


FIGURE 32. Least squares line relating logarithms of age frequencies to ages in relatively unfished areas. The absolute value of the slope of this line is an estimate of the instantaneous natural mortality rate which was converted to an annual mortality figure of 25 percent.

Natural mortality cannot be controlled by man, so it is not possible to prevent large losses that occur to fish populations originating from natural conditions such as disease, predation, and starvation. Fisheries undergo heavy losses before the fish are large enough to catch. However, as long as the weight of the remaining population increases despite natural mortality, the fishery potential is growing. At a specific point the population (and therefore the fishery) reaches its maximum weight. For example, 1,000 kelp bass at age three (average length 8.3 inches)

TABLE 25
Calculated Changes in Total Weight of 1,000 Kelp Bass Sustaining Annual Mortalities of 25 and 30 Percent

Number of fish	*Length inches*	*Age*	*Fish weight ounces*	*Total weight pounds*
		25 Percent Mortality		
1000	8.3	3	4.0	250
750	10.0	4	7.0	328
563	11.5	5	11.0	387
422	12.8	6	15.6	411
317	13.9	7	20.8	412
238	14.9	8	26.0	387
		30 Percent Mortality		
1000	8.3	3	4.0	250
700	10.0	4	7.0	306
490	11.5	5	11.0	337
343	12.8	6	15.6	334
240	13.9	7	20.8	312
168	14.9	8	26.0	273

weigh 250 pounds. In 3 years, at 25 percent natural mortality, when maximum weight is reached, there remain 422 bass weighing 411 pounds (Table 25). At 30 percent mortality, the maximum weight is reached in 2 years and at a lower total than attained at 25 percent mortality.

Assuming the natural mortality rate remains constant, the maximum total weight is attained at 12 inches at 30 percent and 13.4 inches at 25 percent mortality (Figure 33). The greatest yield from a weight standpoint, should be of fish at or near these lengths.

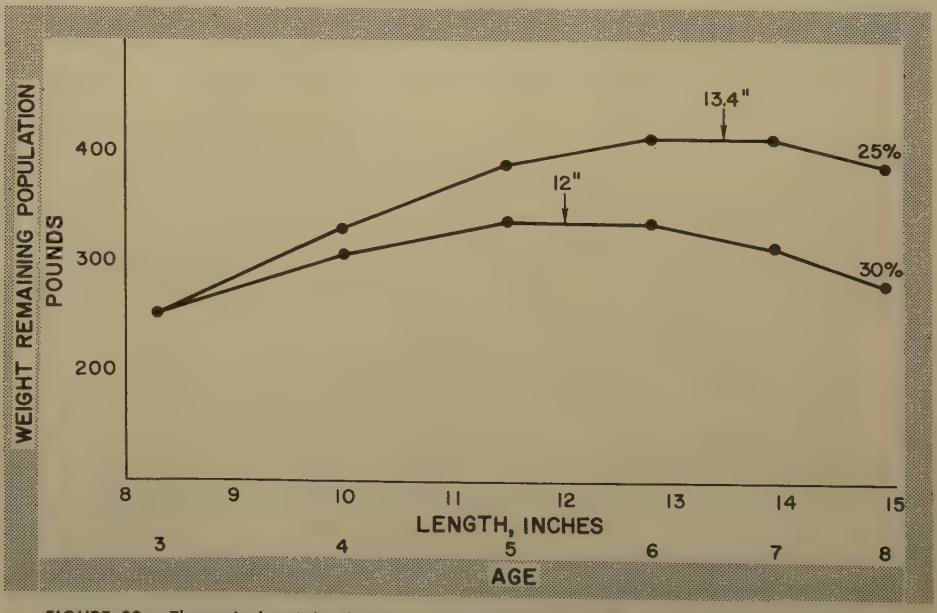


FIGURE 33. Theoretical weight change of a given year-class of kelp bass sustaining successive annual mortalities of 25 and 30 percent. Maximum weight is attained at approximately 13.4 and 12 inches using 25 and 30 percent mortalities respectively.

DEFINITION OF BEST CATCH

In a sportfishery, there are three definitions of best catch: (i) the maximum total number of fish independent of size; (ii) the maximum number of large fish; and (iii) the maximum total weight of fish. Probably the most generally acceptable definition would be the greatest possible total weight of fish (Allen, 1954).

Experience has shown the maximum total number of fish independent of size was not the best exploitation method in the kelp bass fishery. Angling success and desirability was already dropping at Point Dume-Malibu Beach, Rocky Point, San Clemente, Point Loma-La Jolla, San Clemente Island, and Santa Catalina Island in a short period of 7 years (1947 through 1953).

Furthermore, bass grew too slowly to sustain a heavy unrestricted fishery.

To attain the maximum number of large fish requires setting a bag limit to spread fishing evenly over all catchable sizes. In practice a specific bag limit would be required for each of the 12 areas.

The maximum total weight of fish is, in addition to being generally more acceptable, attainable by regulation. To get the maximum total weight of catch, a size limit is set near the point of maximum population weight. Where effort is high, the size limit should be very near; where effort is low, the limit can be lower or disregarded.

REGULATION OF THE BASS FISHERY

As pointed out previously, a kelp bass size limit was set at 10½ inches in 1953. After a series of changes, a 12-inch limit was reached in 1959. The original limit of 10½ inches was supposed to prevent unnecessary hardship on the sportfishing industry working in areas where bass were predominantly small. Although gradual changes were better for the sportfishing industry, stabilizing the fishery at its maximum value was delayed. The duration of the transitional phase (level of catch at time of change to maximum level: Beverton and Holt, 1956), is equal to the fishable life span. For example, the fishable life span of bass after legal recruitment to the fishery may possibly range from a minimum of 3 to a maximum in excess of 10 years, depending upon area. The fishable life span of bass at San Clemente or Point Loma-La Jolla would be much less than at San Clemente Island or Oceanside, barring major changes in fishing effort.

While it is too early to evaluate the effect of the size regulation, it can be speculated upon. In the course of several years, an abundance of sub-legal bass has been noted in areas where there were few prior to 1954. In fact, boat skippers and fishermen alike have found small bass a nuisance in many places.

In 1961, at San Clemente, 34,000 anglers landed 88,300 bass, averaging 2.6 fish-per-man and comparing favorably with some of the better years in the area during 1947 through 1958. The total weight of these fish was presumably much greater than would have been realized from the same number of bass in the early 1950s.

The total catch of bass in 1961 was 613,604 fish, compared with an annual average of 674,468 from 1947 through 1952 and 636,418 from

1953 through 1958. Again, assuming there were relatively few sub-legal bass in the 1961 annual catch, the total weight must have been substantially greater than realized prior to the size limitation.

In fairness, it should be stated that bass angling returns in some areas were not impressive through 1961. However, big game fishing continued to be excellent from 1959 through 1961, sidelining bass to some degree.

SUMMARY

Kelp bass, non-migratory natives of California and Baja California, number among the top five species taken in the California sportboat fishery. Large bull bass, accumulated during World War II, were heavily exploited by 1950, leaving a reduced population individually smaller in size.

REGULATION

In 1953, the California State Legislature prohibited the sale of kelp bass and denied retention by sportfishermen of any bass shorter than $10\frac{1}{2}$ inches. Kelp bass have been protected by bag limits since 1947.

CATCH

In 1935, the California State Legislature enacted laws requiring sportboat operators to keep written catch records.

Historically, the Northern Channel Islands have been one of the better bass fishing grounds; however, the exploitation rate there may have reached the maximum sustainable level during the late 1950's. Santa Monica Bay sportboats have relied chiefly on substitute-incidental species such as mackerel, white croaker, and California halibut to maintain a fishery. Horseshoe Kelp is one of the most important sportfishing grounds in southern California. During and immediately after World War II, Newport Beach was the center of the marine sportfishing industry. Oceanside did not develop extensively as a sportfishing area until 1951.

Lagging bass catches in the latter part of the 12-year period reported here were probably due to a smaller bass population, more fishermen, and increasing competition from game fish. At Point Loma-La Jolla, average game fish catches increased from 1.1 to 3.6 fish per-man from 1947 through 1958. Game fish were the chief target at the Coronado Islands. San Clemente Island was the outstanding bass fishing ground in southern California from 1947 through 1958, and kelp bass provided about half the Santa Catalina Island sport catch during these 12 years.

RELATIONSHIP OF CATCH TO TEMPERATURE

Higher than average water temperatures in 1954, 1957, and 1958 were accompanied by better bass and big game fishing.

TAGGING

In California, bass tagging was carried on from Point Loma north to Santa Cruz Island. Of 956 tags recovered, 68 percent were returned within 6 months, 20 percent within 6 months to a year, and 4 percent within 1 to 2 years.

MOVEMENTS

Data from 458 tag recoveries showed 364 kelp bass were recovered at the release locality, 62 moved as much as 5 miles, 14 traveled from 5 to 10 miles, and 18 moved 10 or more miles. Fourteen bass moving 5 or more miles had traveled from one major fishing ground to another. There was no indication of a relationship between fish length and distance moved.

GROWTH

The equation of a straight line fitted to 81 growth records (tagged bass recoveries) was $Y = 2.94 + .857X$. The longest bass measured by us was 27½ inches long.

AGE

Age determinations were made using scales from 432 kelp bass. The growth equation of the line fitted to the age-length data was $Y = 2.47 + .913X$. The oldest fish encountered (aged from otoliths) was 32.

WEIGHT-LENGTH RELATIONSHIP

The weight-length relationship calculated from data collected from 356 bass gave the equation $W = .00376L^{3.27}$. The heaviest bass we weighed was 14 pounds 9 ounces.

FOOD

In general, bass shift their diets from small forms of animal life to fish and cephalopods with growth.

MATURITY

Maturation occurs as early as April. Fish as small as 201 mm were mature by June, and by September and October, spawning had been completed. Of 65 kelp bass examined for hermaphroditism, ovarian tissue was found in the gonad of one male. The tissue appeared to be *in situ*, but may have been deposited during laboratory processing.

DISCUSSION

Based on a sample of 293 bass taken at the three relatively unfished areas of Santa Cruz, Santa Barbara, and San Clemente Islands, the natural mortality rate was computed as 25 percent. A given year-class of kelp bass enduring natural mortality of 25 and 30 percent annually, would reach their maximum attained weight at about 13.4 and 12 inches respectively.

Three definitions of best catch (sportfishing) are:

1) The maximum total number of fish independent of size.
2) The maximum number of large fish.
3) The maximum total weight of fish.

REGULATION OF THE KELP BASS FISHERY

A 12-inch size limit was instituted in 1959. While it is too early to evaluate the full effect, an abundance of sub-legal bass has been noted in areas where there were few prior to 1954.

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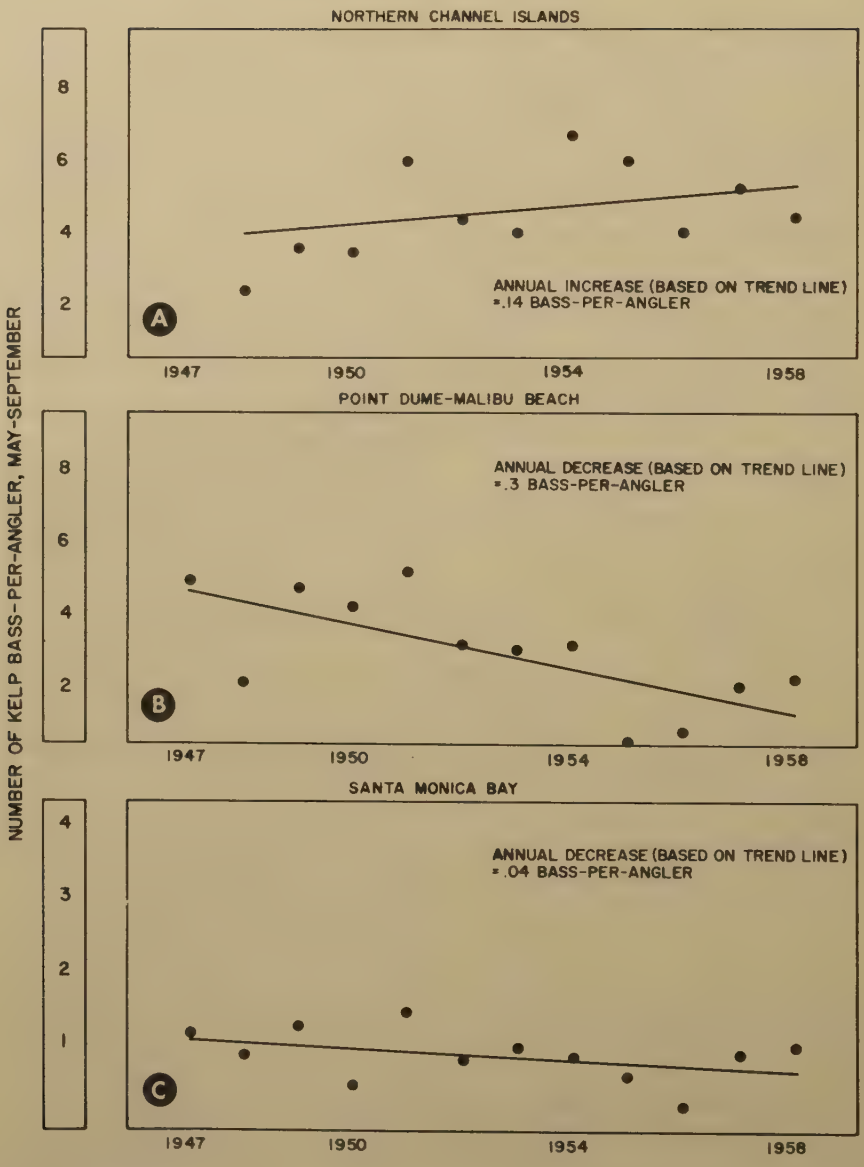
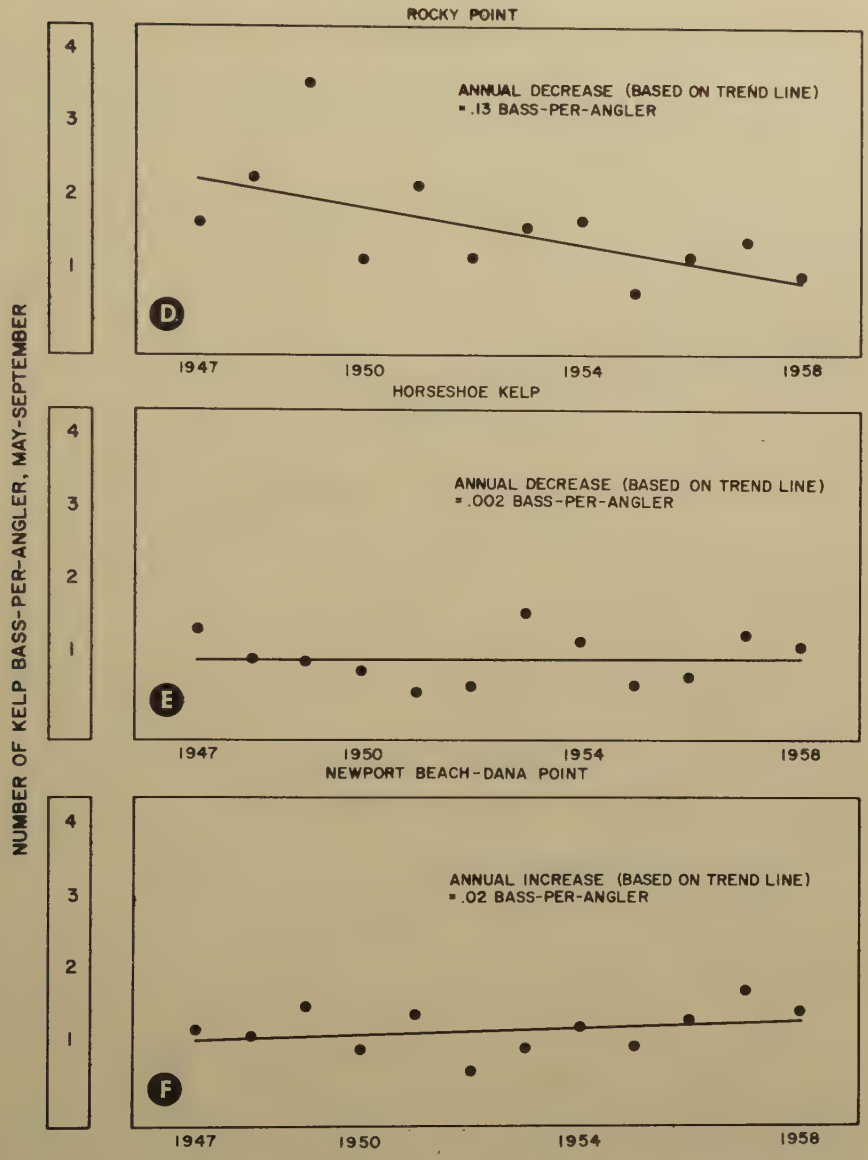


APPENDIX FIGURE 1-A. Number of kelp bass-per-angler, Northern Channel Islands, May-September, 1948-1958.

APPENDIX FIGURE 1-B. Number of kelp bass-per-angler, Point Dume-Malibu Beach, May-September, 1947-1958.

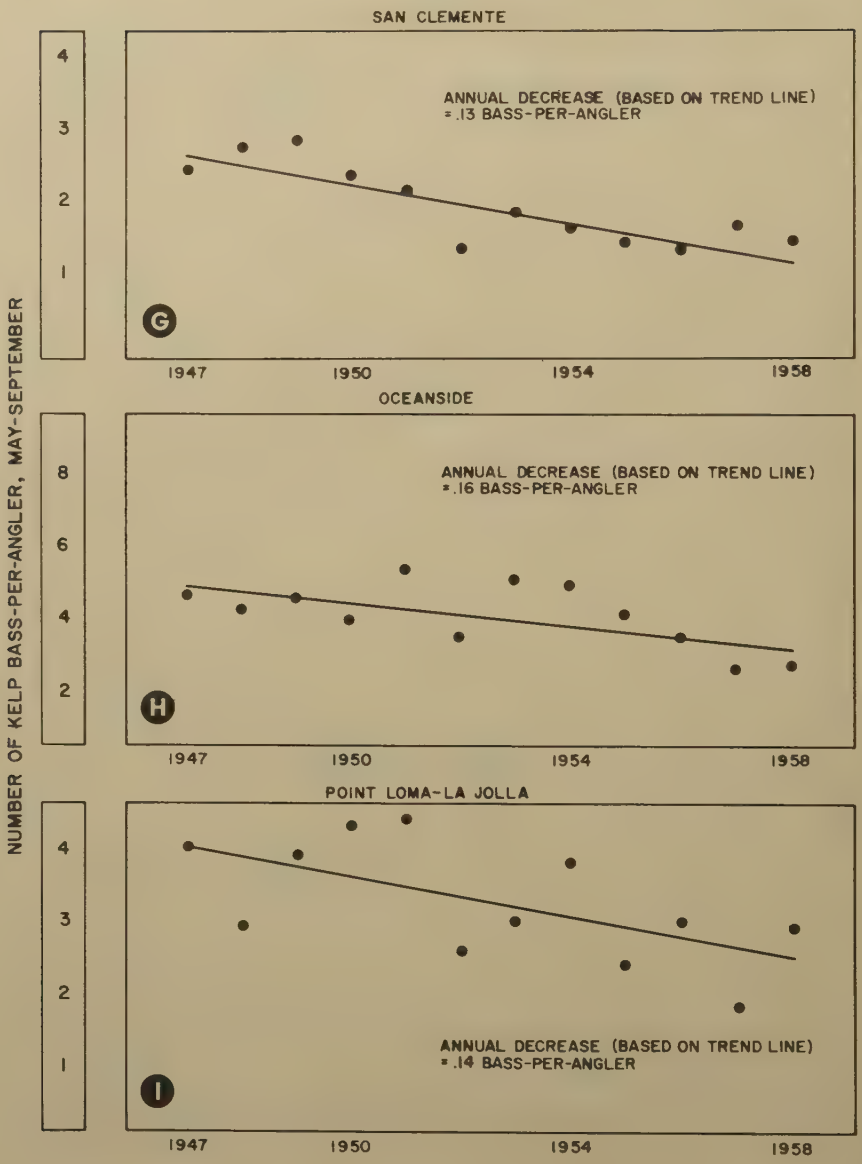
APPENDIX FIGURE 1-C. Number of kelp bass-per-angler, Santa Monica Bay, May-September, 1947-1958.



APPENDIX FIGURE 1-D. Number of kelp bass-per-angler, Rocky Point, May-September, 1947-1958.

APPENDIX FIGURE 1-E. Number of kelp bass-per-angler, Horseshoe Kelp, May-September, 1947-1958.

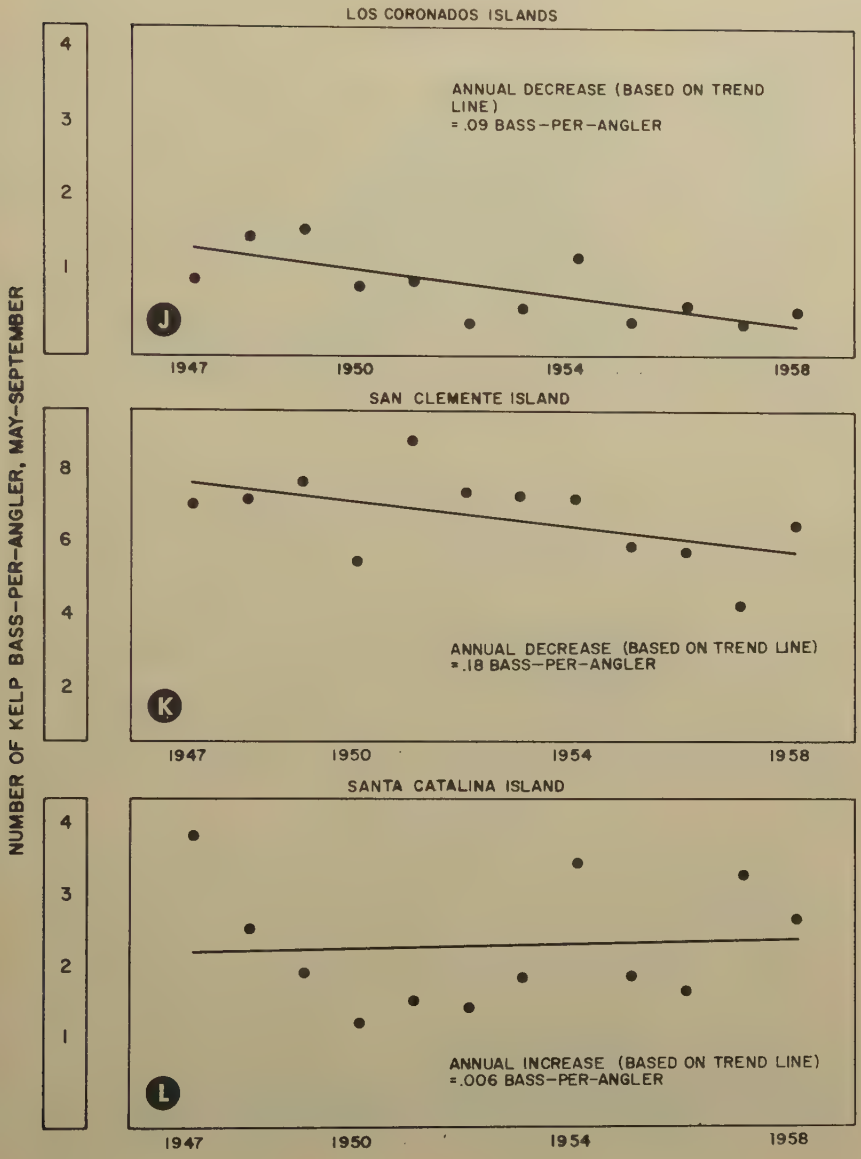
APPENDIX FIGURE 1-F. Number of kelp bass-per-angler, Newport Beach-Dana Point, May-September, 1947-1958.



APPENDIX FIGURE 1-G. Number of kelp bass-per-angler, San Clemente, May-September, 1947-1958.

APPENDIX FIGURE 1-H. Number of kelp bass-per-angler, Oceanside, May-September, 1947-1958.

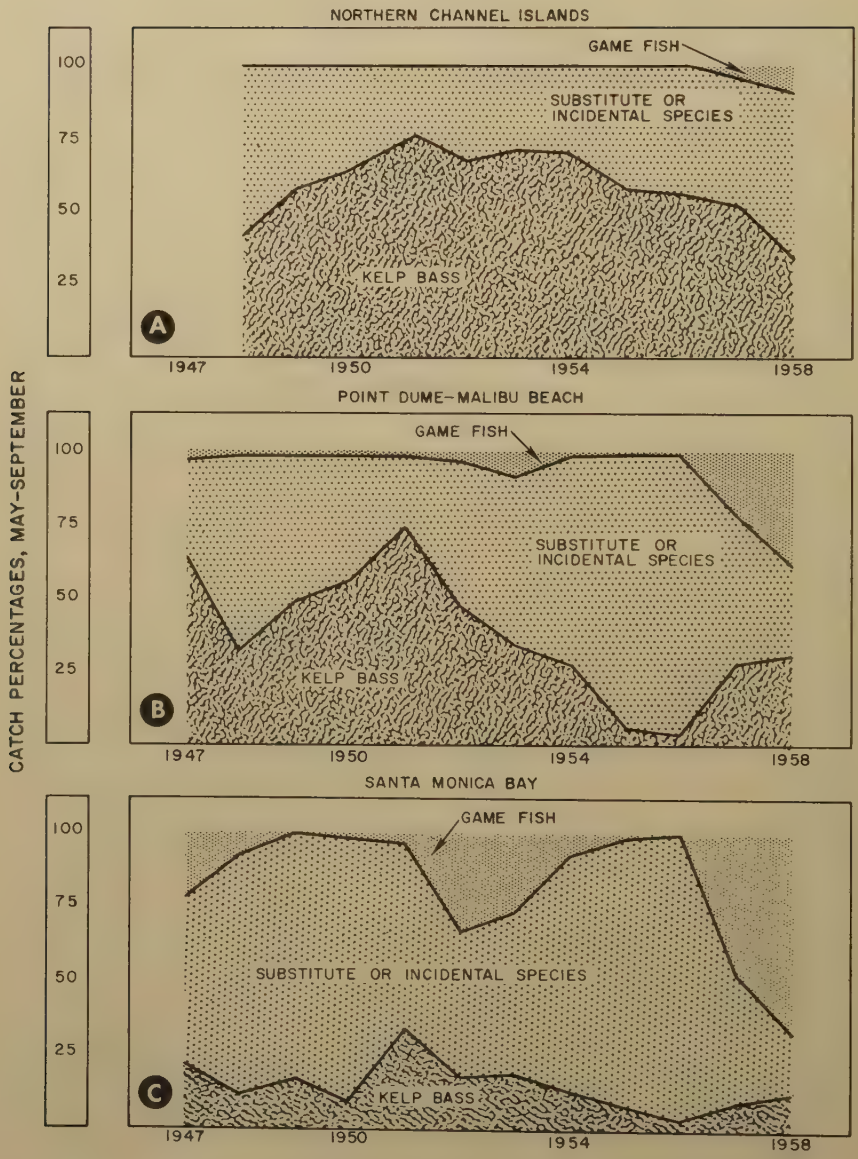
APPENDIX FIGURE 1-I. Number of kelp bass-per-angler, Point Loma-La Jolla, May-September, 1947-1958.



APPENDIX FIGURE 1-J. Number of kelp bass-per-angler, The Coronado Islands, May-September, 1947-1958.

APPENDIX FIGURE 1-K. Number of kelp bass-per-angler, San Clemente Island, May-September, 1947-1958.

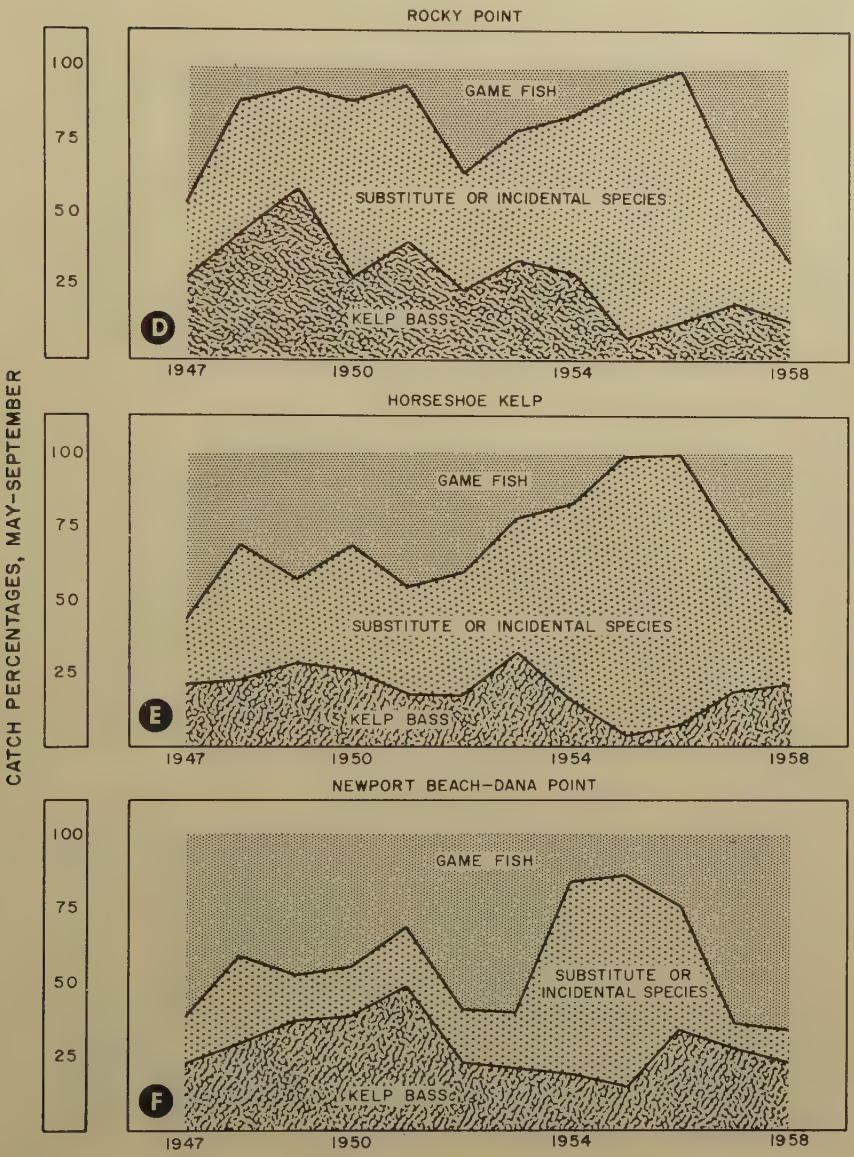
APPENDIX FIGURE 1-L. Number of kelp bass-per-angler, Santa Catalina Island, May-September, 1947-1958.



APPENDIX FIGURE 2-A. Catch percentages, fish groups I and II, Northern Channel Islands, May-September, 1948-1958.

APPENDIX FIGURE 2-B. Catch percentages, fish groups I and II, Point Dume-Malibu Beach, May-September, 1947-1958.

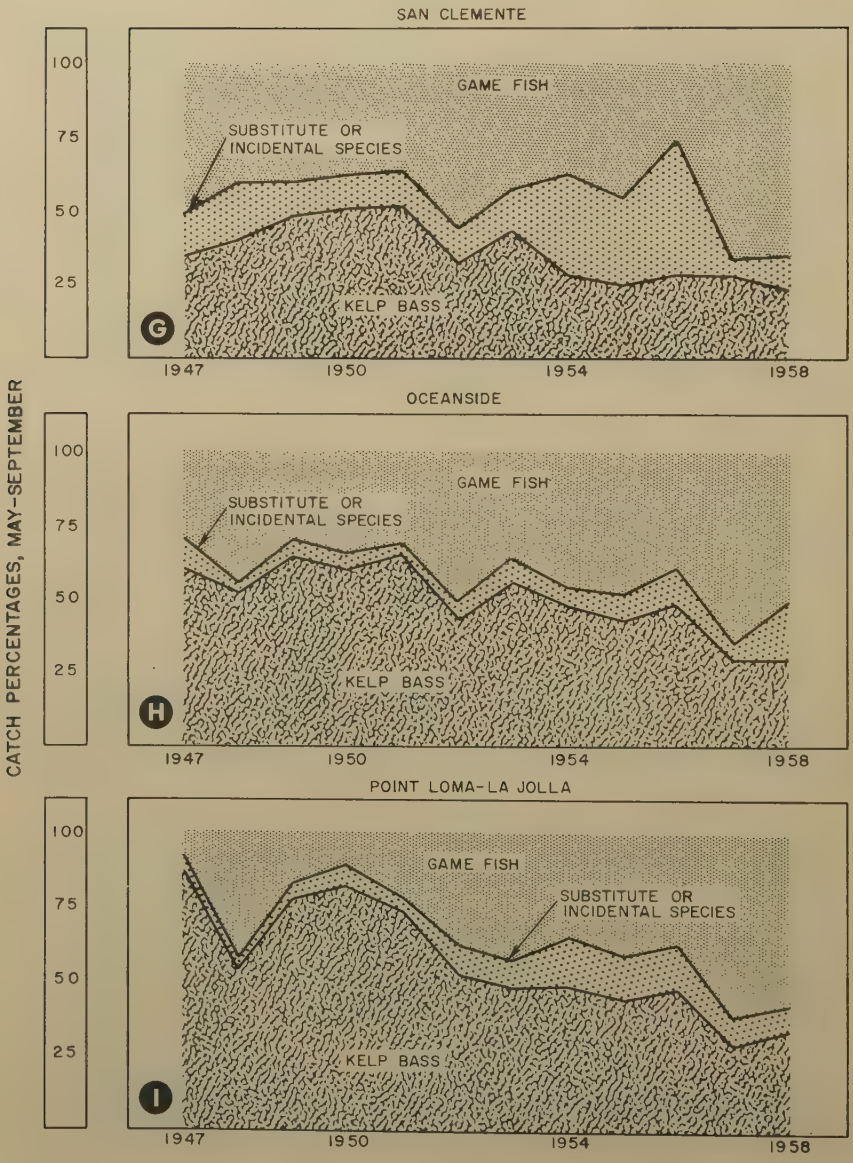
APPENDIX FIGURE 2-C. Catch percentages, fish groups I and II, Santa Monica Bay, May-September, 1947-1958.



APPENDIX FIGURE 2-D. Catch percentages, fish groups I and II, Rocky Point, May-September, 1947-1958.

APPENDIX FIGURE 2-E. Catch percentages, fish groups I and II, Horseshoe Kelp, May-September, 1947-1958.

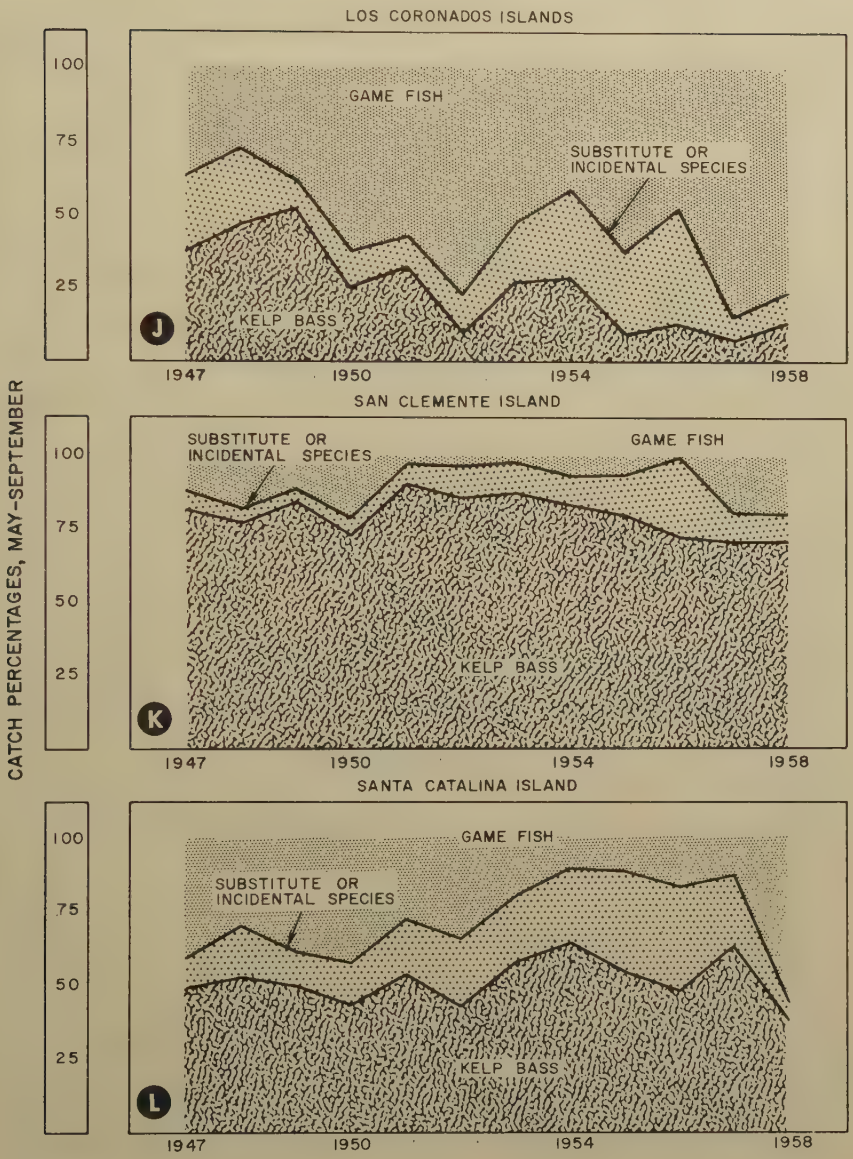
APPENDIX FIGURE 2-F. Catch percentages, fish groups I and II, Newport Beach-Dana Point, May-September, 1947-1958.



APPENDIX FIGURE 2-G. Catch percentages, fish groups I and II, San Clemente, May-September, 1947-1958.

APPENDIX FIGURE 2-H. Catch percentages, fish groups I and II, Oceanside, May-September, 1947-1958.

APPENDIX FIGURE 2-I. Catch percentages, fish groups I and II, Point Loma-La Jolla, May-September, 1947-1958.



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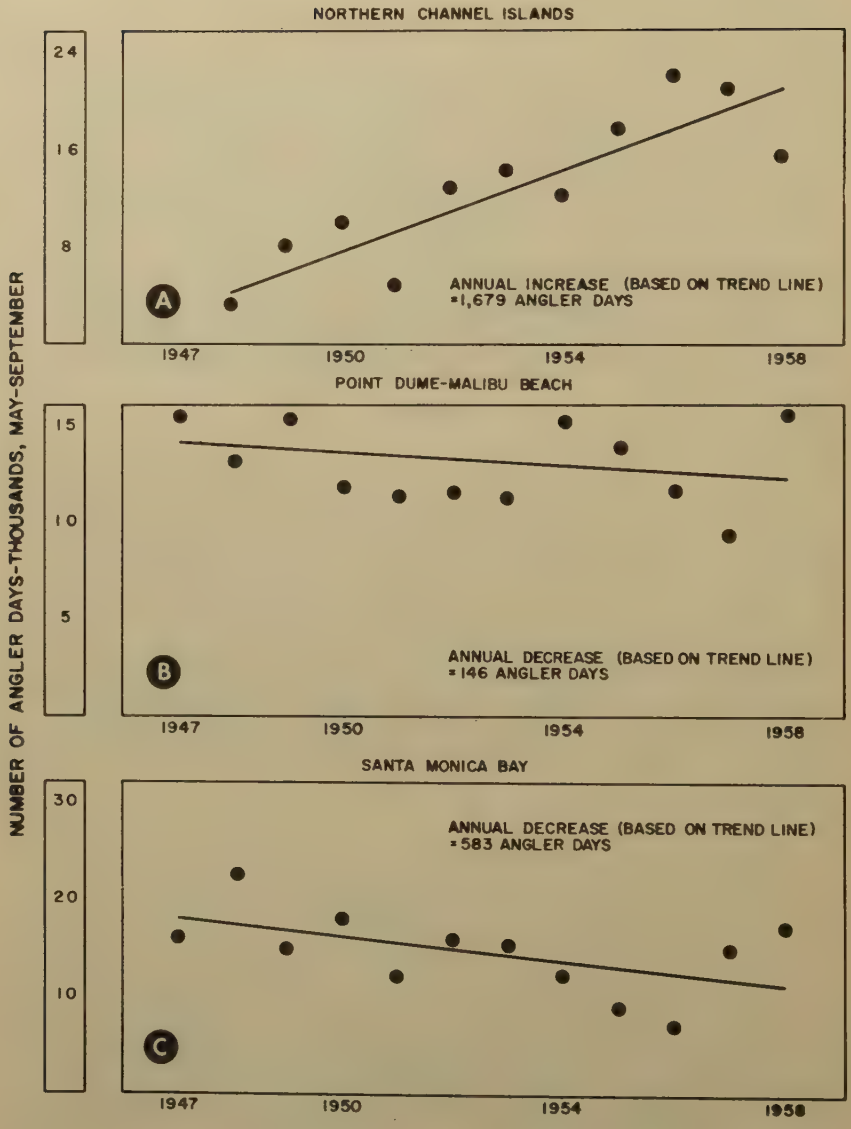
APPENDIX FIGURE 2-K. Catch percentages, fish groups I and II, San Clemente Island, May-September, 1947-1958.

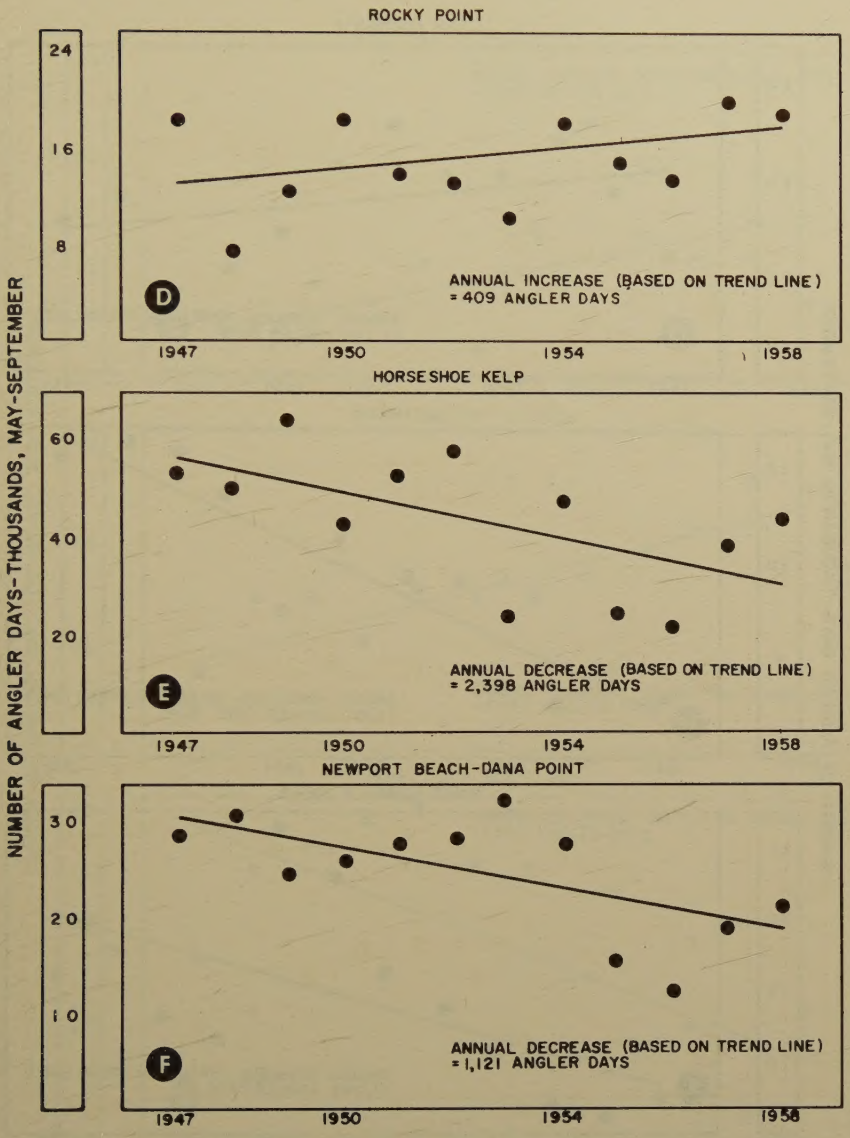
APPENDIX FIGURE 2-L. Catch percentages, fish groups I and II, Santa Catalina Island, May-September, 1947-1958.



APPENDIX FIGURE 3-A. Number of anglers, Northern Channel Islands, May-September, 1948-1958.

APPENDIX FIGURE 3-B. Number of anglers, Point Dume-Malibu Beach, May-September, 1947-1958.

APPENDIX FIGURE 3-C. Number of anglers, Santa Monica Bay, May-September, 1947-1958.



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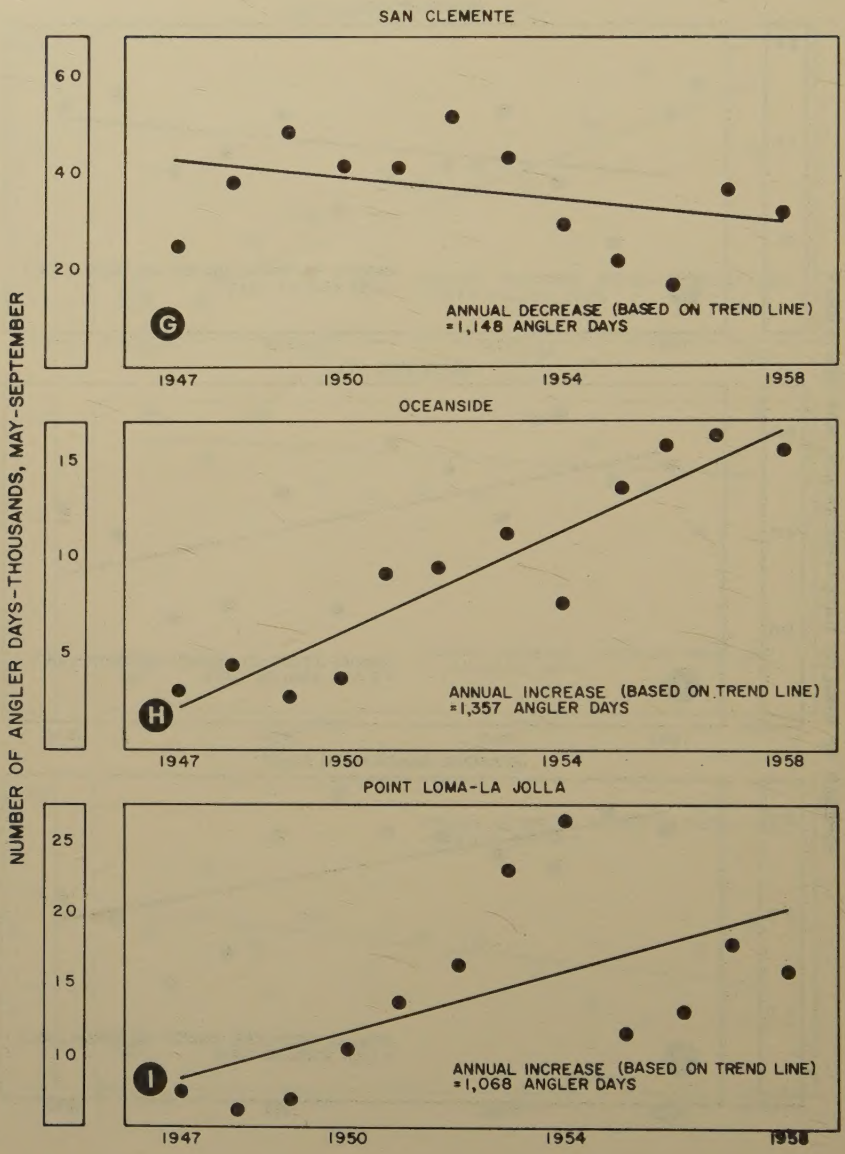
APPENDIX FIGURE 3-F. Number of anglers, Newport Beach-Dana Point, May-September, 1947-1958.



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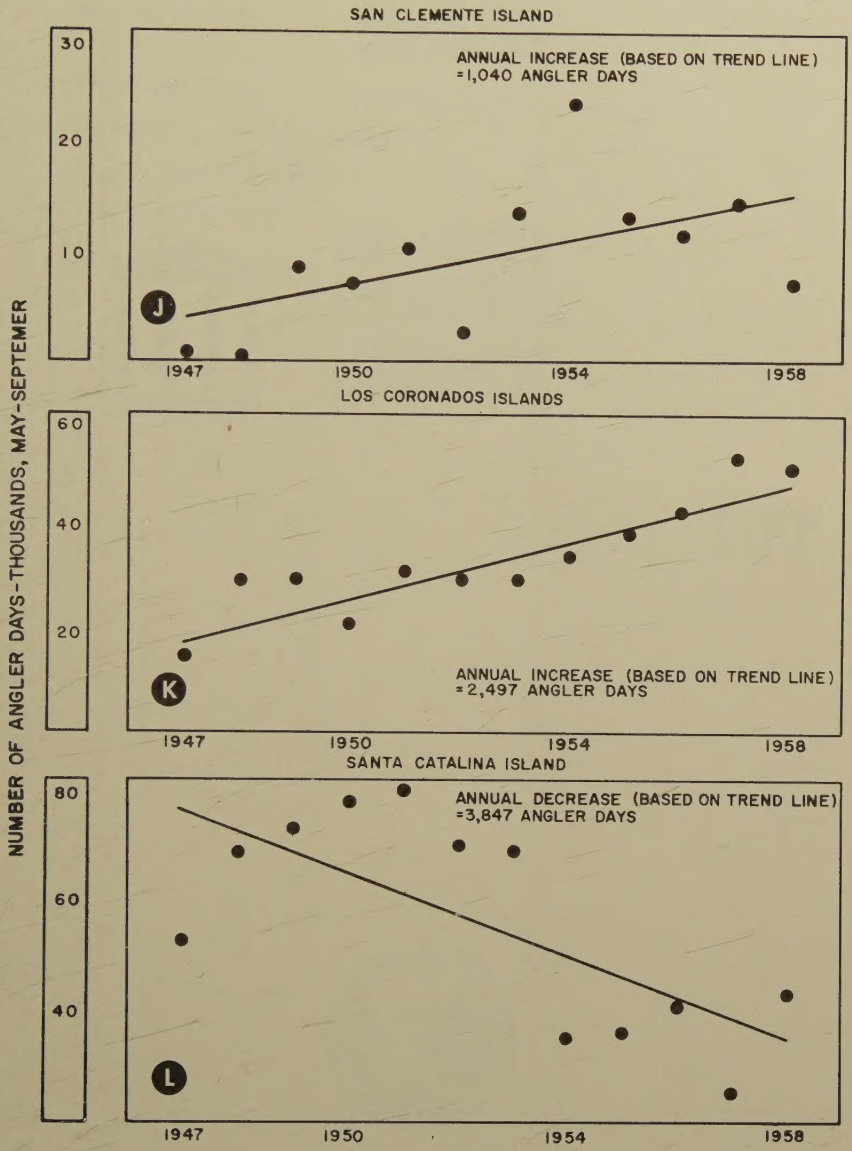

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